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ELECTRICAL GROWTH IN 1904.

Pursuant to our usual plan, we give below an estimate of the value of the electrical apparatus, distinctively such, produced in the United States during 1904. As will be seen, the amount is $175,500,000. This compares with an estimated total in 1903 of $158,650,000, or a gain of $16,850,000, which is slightly better than 10 per cent. We have some doubts as to whether, on the whole, this rate of increase was secured. In good years, and over a long period, the annual rate has been not far short of 20 per cent. gain, but 1904 was confessedly a bad year during its first half, and it is open to question whether the second half could have made such strides as to wipe out deficits and pile up a 10 per cent. gain for the whole twelve months. Still it is possible, especially as some of the departments of the industry, such as telephony, kept up a smart advance all the time. The table is as follows:

	1903.	1904.
Dynamos	$17,000,000	$18,500,000
Transformers	5,000,000	5,000,000
Switchboards for lighting and power	2,750,000	3,000,000
Motors for all purposes, including traction	30,000,000	35,000,000
Storage batteries	4,500,000	5,000,000
Primary batteries	1,250,000	1,250,000
Carbons	2,000,000	2,250,000
Arc lamps	2,250,000	2,500,000
Incandescent lamps	5,500,000	6,000,000
Lighting fixtures	3,750,000	3,750,000
Telephonic apparatus	25,000,000	30,000,000
Telegraphic apparatus	2,000,000	2,500,000
Insulated wires and cables, submarine cables	30,250,000	35,000,000
Conduits, interior and underground	1,750,000	2,000,000
Rheostats, heating and cooking apparatus	2,500,000	3,000,000
Annunciators	250,000	250,000
Electric clocks	150,000	150,000
Lightning arresters, fuses, etc.	750,000	1,000,000
Measuring instruments	3,000,000	3,350,000
Miscellaneous apparatus	19,000,000	20,000,000
Grand total	$158,650,000	$175,500,000

The United States Census Bureau takes its five-year census of manufacturing in 1905, so that we shall soon have a chance of knowing how nearly these estimates hit the mark.

It may be noted, in addition, that the work done by public service corporations for the community now runs into large figures. At a moderate rate of increase over previous years, the telegraph companies in 1904 earned about $40,000,000; the telephone companies, $110,000,000; the electric light companies, $125,000,000, and the street railway companies between $275,000,000 and $300,000,000, say $290,000,000. Here we have a gigantic total of $565,000,000 earned by the four great branches of electrical industries, to which, added the $175,000,000 from electrical manufacturing, would roughly make the electrical bill of the American public in 1904 not less than $740,000,000. It was, however, more than that amount.

ELECTRIC FREIGHT HAULAGE.

Mr. Leonard's article on electricity in heavy railway work, printed elsewhere in this issue, is important as drawing attention to a little considered feature of the subject. We have become so used to talking high speed that the relation of power to speed has sometimes dropped out of sight. In the last report the reasons for using electric traction for very high-speed service and for the heaviest freight service are akin, for the real question is the continuous supply of much larger amounts of power than are in common use. But in freight hauling there is the advantage that economy lies in trains requiring large power, while in express service the power is still needed but cannot be applied to produce a gain in economy. In either case the limitation on steam locomotives is their inability to generate adequate power for the modern requirements placed upon a single unit. There is a limit to the economical size of power sta-

tions on wheels. Mr. Leonard's conception of the ideal freight train as composed of a group of coupled train units under simultaneous control is an interesting one. Such an organization would certainly tend to economy in the general transportation charges and would probably also reduce the danger of accidents. The fundamental difficulty with any such service is the difficulty of power distribution, where the moving units are of so great aggregate capacity and the distances so long as they are in trunk line freight haulage. Mr. Leonard's proposed train with its six or seven thousand kilowatts demand for power at the terminals is a far more formidable proposition than anything yet projected.

Units of this size imply a distribution on a colossal scale in order to secure a reasonable degree of economy in generation. Their use is utterly out of the question at the voltages of distribution now in use, and is only possible in case of carrying very high pressure on the working conductors. Third-rail supply and indeed every kind of direct-current supply is practically barred from the start, as indeed it is for all serious railway work over long distances. Mr. Leonard's own scheme of distribution, or an alternating current motor of a size or type unimagined, seems about the only possible refuge when it comes to work of such magnitude. As we intimated when Mr. Leonard's device was taken up by Huber at the Oerlikon works, it offers by far the most complete control for an alternating-current distribution yet worked out, and we would much like to see it tried on a considerable scale, for in spite of its apparent complication it offers certain unique advantages. From all reports, too, some rather large commutating alternating motors have been developed at the Oerliken works of which we may hear more anon. Electric traction on the largest scale will have to wait for some such radical departure in apparatus. Railway engineers stick to their 500 or 600 volts as the lighting men of fifteen years ago stuck to their 110-volt mains. Everything else was "experimental" or "unpractical" or something else objectionable, and the only salvation of the business was to stick to the "well-tried" low tension system, with "standardized" apparatus. The same old words to a slightly different tune greet our ears at every suggestion of radical innovations in electric traction. Possibly after some of our foreign friends have done the thing for a few years, we may get something like it on this side of the water. At all events, we live in hope.

MUNICIPAL PLANT POLITICS.

If ever there were any question as to the direct relation between municipal plants and politics, the facts are being freely furnished in New York City at the present time. With a loud-mouthed profession of desire to promote public welfare, the newspapers and the politicians are doing their worst to muddle the people, and, for the sake of the politics in it, are trying to make out that New York City is robbed by its electric lighting service under private contract. The real, solid truth is, and we assert it without any fear of possible contradiction, New York is given to-day an excellent, cheap and trustworthy supply of electric street lighting unsurpassed in the world; yet without a shred of data to support the contrary assertion, all manner of politicians and journals are shouting that the city is not treated fairly. It makes one sick. All that can be got out of it as an explanation is that Mayor McClellan and Mr. Hearst are playing for position, and Governor Odell "is in hearty accord with such legislation, because he believes this course will increase Republican popularity in New York City." There you have it in a nutshell.

Mayor McClellan as a Democratic leader comes out in his New Year message and says he is against government ownership, yet favors a municipal plant. This is good logic, but will serve his purpose. Then the newspapers take their fling, using, like the Mayor, the same old falsities fathered on Engineer Lacombe as to electric lighting overcharge in New York City as compared with other places —with a list in which on any right basis of comparison there is not one genuine true item. However, let that pass, and let us endeavor to find out what the newspapers think they want, for evidently they do not know what they are talking about. The *Evening Post* says: "Already the Tammany Mayor and Comptroller are taking the wind out of the sails of the men who have been assailing them on this line; and, if hard-pressed politically, the Wigwam is quite capable of going its antagonists several better, and promising municipal ice houses, city meat shops, a municipal stock exchange and municipal saloons." We would be greatly obliged if the *Post* would tell us what it really favors. It seems to oppose anything more than a service of the city by itself and flouts a commercial business. Next comes the *Globe*, berating the New York Edison Company, but making this remark: "If it could keep public lighting entirely apart from private lighting, there would be no serious objection to the establishment of a municipal plant; but the chances are very great that the moment such a plant demonstrated the city's ability to furnish public lighting at less prices than the private monopoly charges, private consumers would demand that they be given the benefit on equal terms with the city. This demand would, of course, have to be granted, for no administration would venture to refuse it. Once granted in regard to gas and electric light, the demand would come for other concessions, like city ownership of street railways with lower fares, and we should then be plunged into a condition of things the like of which no city in the world has ever known." But the New York *American* goes the whole hog and says, bluntly: "On the other hand, to put up a plant and lay wires for lighting city streets and municipal buildings only, would result in a cost of light as great, and probably more, than the present exorbitant price charged by the Trust, while the citizens themselves still would be at the mercy of the Trust." In view of the fact that in 1902, out of 815 municipal electric light plants all but 77 had been driven by their necessities into selling current and light to private consumers, the Hearstian idea has evidently more foundation than the timid vaporings of the *Post* and the *Globe*.

As will be noted, even the *American* in its franker moments is compelled to admit that a city plant cannot be run at a profit if it simply supplies the city; and we would add that on Manhattan Island it cannot be run at a profit on any basis. Besides, the lighting business is only one item that the municipal ownership grabbers are after, for even as we write the Bureau of Highways is out for a municipal asphalt plant. We cannot help wondering how long the business men of New York will put up with such politics, such jobs and such attempts at confiscation that strike at the roots of all property, society and civilized advance.

AREAS OF ELECTRIC LIGHT DISTRIBUTION.

There is a strong tendency now manifest toward the consolidation of small electrical supply stations, or perhaps one should say the absorption of small stations into large systems. How far this process is likely to extend is uncertain, but inquiry into its real and supposed advantages is evidently pertinent. Take for instance the case of a city and its suburban district. How far will it pay to concentrate the plant for the whole region, distributing therefrom to the regions formerly fed by the local stations? The exact meaning of "paying" determines the character of the answer. If we confine ourselves to the engineering side of the matter, the question resolves itself into the relative economy of generating in small stations as against generating in one or two large stations and transmitting the energy over a whole district. But other considerations enter such a discussion practically, such as the effect of the absorption in wiping out possible competition, its value in increasing business and the opportunity it

offers for the easy extension of capitalization against the day in which the main plant might show earnings that would justify a demand for a reduction of price. All these things have their weight in determining the issue, generally a much greater weight than the advantages of the change from an engineering standpoint. It is from this last direction, however, that we must here consider it, for we have no desire to seek fame in the maze of high finance.

The average suburban plant represents a relatively heavy investment owing to the scattered nature of its service, has a relatively large amount of that investment in the lines of which the depreciation is considerable, nearly always has a large amount of lost current and inevitably a bad load factor. All these things conduce to high cost of energy and low general efficiency. Consequently, as a rule suburban plants charge rather stiff prices for energy and rarely give a first-class service. The high price keeps down the demand and not a few such plants have, therefore, come to grief financially. On the other hand, in large suburban places a plant is now and then found giving excellent service at moderate prices and paying well. In the process of absorption what will be the effect on plants of these two classes? To begin with, the large investment and heavy depreciation in the service of a scattered market must remain. The delivery of transmitted power to the plant does not of itself alter the nature or difficulties of the service. The losses from scattered transformers and such like causes also remain until the distributing plant is remodelled, but the load factor is merged in that of the central plant and is therefore improved. If a saving in the cost of energy can be made after allowing for the expenses of transmission, as will often be the case, then the operating costs can be cut down by such amount and also a certain part of the administrative expense, which is generally abnormally high in small plants, can be saved. Therefore, it is feasible, and here is the really important consideration—to make such concessions in the price of energy as will build up a denser service and thus reduce the distribution costs. Without this gain, taking on a distant suburban service would be a very small advantage to the central plant. In this gain the customer shares, and all parties concerned are benefited. In addition, the abolition of a small station in this way generally means better and more reliable service, which again helps all around.

Consolidation under these conditions is generally, therefore, a good thing for all parties, and the territory thus covered to advantage is limited only by the distance within which the transmitted energy can more than hold its own—a distance shorter, we think, than is generally estimated, but still covering a pretty large suburban territory. Over against these favorable cases stand some of another kind. These are plants in rather large suburban places having already fairly dense business and respectably good load factors. Their rates will be found substantially upon a metropolitan basis, and in virtue of their size their general and distribution costs are moderate. In some such cases the actual distribution costs will be found less than in a neighboring metropolitan district owing to a less difficult territory and more moderate distances. Any savings here made by consolidation must be pure gains in generating costs. Under the circumstances these are unlikely to be large, although they are sometimes sufficient to warrant taking the system aboard. In many instances, financial rather than engineering considerations decide this particular kind of a case. If a large increase of stock is contemplated, a good plant or two is needed to sweeten the general collection of dubious ones and help tide them over a period of reorganization. In general terms, a well-run plant in a large suburban place with a good territory and dense business has nothing to gain by consolidation. It is and will remain a valuable property, the more so since the regulation of the prices charged by supply stations will generally prevent unfair competition, and as a rule no real competition can enter. When such a plant is taken over for consolidation it is merely a case of the big fish swallowing the little fish, which is often a good thing for the former and in which the latter is seldom consulted. One of the advantages of serving a big area from a single station is the freedom gained in dealing with motor load owing to the large scale of the operations. It is very unusual to find a plant of moderate size with a well-developed motor load, owing to disinclination to take big units on the distributing system. As the source of supply is shifted to stations of large capacity, it gets progressively easier to build up a motor business, which ought to be a very important and well-paying part of the total load. In the ideal city all power should be supplied from a distant plant instead of being generated under smoking chimneys, and it seems to us that in this way the big consolidations which are now the order of the day are a move in the right direction. But individual suburbs may still have nothing to gain from electrical consolidation just as they have nothing apparently to gain by annexation.

PRESENT STATUS OF INDUSTRIAL ELECTROCHEMISTRY.

The past year has witnessed no striking addition to the electrochemical industries, but there has been no relaxation in the steady progress in the perfection of details whereby established industries are placed on a firmer basis and the field thus prepared for further development. The electrochemical industries in the past year have, in fact, followed a healthy, business-like process of development which gives promise of good for the future; for nothing could be more harmful to the future of electrochemistry and electrometallurgy than a reckless investment of large amounts of money in half-baked schemes and in dreams of inventors. It may be said that electrochemistry has stepped in to take up problems to which industrial chemistry gave partial solution and then abandoned as beyond its powers. Where the older chemical methods failed, in many cases the use of the electric current brought success. Thus the first triumphs of electrochemical methods were won in the production of compounds, such as calcium-carbide, carborundum and artificial graphite, requiring temperatures not attainable by ordinary means, and in the conquest of those compounds of strong metals like aluminum which defied economical treatment by the older methods. The old chemical methods have had their most recent triumphs in the field of organic chemistry, while electrochemistry has commenced its work were that branch left off in the realm of inorganic chemistry.

That there was left, however, an enormous field in inorganic chemistry for the application of electrochemical methods may perhaps best be realized from the fact that the solid crust of the earth contains 58.3 per cent. silicon oxide, 14.7 per cent. aluminum oxide, 7.8 per cent. iron oxide, 5.3 per cent. calcium oxide and 4.5 per cent. magnesium oxide. With the exception of the production and treatment of iron—the oldest metallurgical art—all the other elements mentioned above were left to the electrochemist. The aluminum industry is now firmly established; silicon is being made at the works of the Carborundum Company at Niagara Falls on a commercial scale; calcium is made commercially in Germany, and the electrochemical production of magnesium has also proven a success. There is, of course, still a wide field open for the improvement of methods of manufacture, yet the possibility of the economical electrochemical production and treatment of these elements is proven beyond doubt. What is most important at present, however, for the development of the silicon, calcium and magnesium industries, is to find uses for these materials, just as in the case of aluminum ten years ago. Important commercial developments of electrochemistry in the near future are probably also to be expected in the metallurgy of the common metals. It is at the last stage of a metallurgical process that electrochemistry steps in—in the refining of metals or in the

making of special products. Millions of dollars' worth of copper are now refined monthly in electrolytic refineries. The purest nickel on the market is refined electrolytically. Electrolytically refined zinc is sold in competition to the so-called sterling zinc. The refining of lead by the Betts process is making steady progress in Canada. Burgess succeeded last year in making pure iron electrolytically—a result which promises to become an important starting point for the systematic investigation of iron alloys.

Besides the work in these fields, which are essentially electrochemical, there has been manifested a constant endeavor to extend the scope of electrochemical methods. This has been especially notable in the electric furnace field, which is about to extend to reactions which do not require excessively high temperatures. The experience of past years with the electric furnace has taught the furnace designer how to maintain the temperature within or at different portions of the interior, at a desired intensity. Without the application of careful design enabling the holding of temperature within fixed limits, Tone's silicon furnace would have been impossible. The electric furnace is now even applied to the metallurgy of zinc, which requires a comparatively low temperature. The directness, cleanliness and easy control of the electric furnace has made its use a commercial success for the production of special steels to compete with crucible steels, which, aside from the production of ferro-alloys, marks the first entry of electrochemical methods in iron and steel metallurgy. Among electrolytic processes besides those for metal refining, those for the production of caustic alkalies and chlorine are still in the front rank. In this case it has been possible to overcome a difficulty inherent in every electrolytic method, namely, the tendency of the current to constantly change the original conditions where such conditions should be maintained to the end. This difficulty is in general easier to overcome in the electrolysis of simple inorganic compounds, and much work will have to be done before electrolysis can play an important part in industrial organic chemistry. In the latter case there is apt to be such a great variety of possible compounds which can be formed in a solution by the electric current that it seems most difficult to confine the work of the current to the one reaction which is wanted.

Among processes using electric discharges through gases, the production of ozone and of nitric acid from air still attract the most attention. The production of ozone by silent discharges and the use of ozone for sterilizing water have proven industrially successful in Europe, and attempts are being made at present to introduce the processes in this country. The production of nitric acid from air by means of arc discharges appears still as far removed as ever from industrial success. The large experimental plant in Niagara Falls has ceased operation, but other inventors are continuing their efforts and there appears no fundamental reason why this most important problem should not finally be solved. The greatest obstacle to a speedy development of electrochemical methods in general is at present the high price of electrical energy compared with the price of other forms of energy. In very many cases the charge for electrical energy is one of the most important items on the cost sheet. For this reason cheap electrical energy generated from water power has naturally always attracted electrochemical industries. But it seems at present that water power may have a strong competitor in gas power. As an example of what may come, the following combination has been suggested and even in Europe applied: Blast furnaces for making pig iron; open-hearth furnaces and Bessemer converters for making structural steels from the pig iron; the use of the blast furnace gases for driving gas engines coupled to electric generators, and the use of resulting electrical energy for mill power purposes in general, and in particular for the operation of electric furnaces producing special steels of the quality of the crucible steels.

THE STORAGE BATTERY.

When one considers the present widely extended use of the storage battery in power stations, and then looks back to the time when it was regarded by engineers with distrust and suspicion, the conviction forces itself that this former "ugly duckling" of the electrical art has, in its later perfection, proven to be a swan. In the earlier days many aphorisms were based on the alleged impracticability of the storage battery. "The infernal thing is wet," and "The chief value of an alternating current is that no darned fool can put a storage battery in circuit with it," were among the choice bits of humor circulated at the expense of this despised contrivance. The growing use of batteries abroad, however, and the economical results attendant upon their effect on the leveling of load curves, cutting off peaks and filling in the hollows, finally compelled the consideration of American central station operators, and cautiously, doubtingly, a few batteries were installed here. The opportunity to prove their value being given, from that time on, their use has extended, until now the design of power plants, the copper distribution of electrical systems and the character of the generating units, are modified to conform to the easier load requirements incident to the installation of batteries, which have come to form an integral part of almost every modern equipment.

The principal uses of the storage battery in power plants are in the absorption of variations in widely and suddenly fluctuating loads, and in carrying peaks which extend over a comparatively short time; but to the central station manager the fact that the battery is always a guarantee against shutdowns and will supply energy in case of failure of any part of the generating equipment, is perhaps its greatest recommendation. An example of this reliance in the battery for continuous operation is their employment even in alternating-current stations, where they are connected across the exciter bus-bars and never serve any useful purpose if the exciting dynamos always work properly. If the exciters fail for one instant, the batteries will supply current to the alternator fields and the station is not shut down as would be the case if the battery were not there, ready for this emergency. The heavy depreciation which has militated seriously against a more widespread adoption of this helpful auxiliary, is largely due to the fact that nearly every battery is too small for the work it has to do. When a purchasing agent of the class which follows too literally the aphorism, "A dollar saved is a dollar made," looks at the figures for a complete battery equipment of proper capacity, he is liable to heart failure if not of strong constitution. A compromise of less money for less battery means an overworked battery, and the complaints which follow are a logical and inevitable consequence.

Since the voltage of a storage battery on discharge gradually diminishes, some means of compensating for this decrease is necessary to maintain constant line voltage. There are, in general, two methods. The one most widely employed is the end cell system, in which additional cells are switched in series with the main body of the battery as voltage decreases, and by the addition of these end cells the drop in the main cells is neutralized. A more recent arrangement, now much used in England but not adopted in this country up to the present time, employs a dynamo-electric machine having its armature in series with the battery circuit and provided with a rheostat in its field circuit, by means of which the excitation, and consequently the armature voltage, can be varied from zero to a maximum in either direction. When the battery voltage is equal to that of the line the dynamo voltage is zero, and the current passes from the battery to the line, through the armature. At the beginning of discharge the voltage of the battery is somewhat in excess of that of the line, and the dynamo, or booster, field is excited so that the armature e.m.f. is in opposition to that of the battery, and is equal in value to the excess of battery voltage above that of the line. As

the battery voltage falls, the booster field excitation is reduced until the battery e.m.f. becomes equal to that of the line, at which point the booster field excitation becomes zero. As the decrease in battery voltage continues, the booster field is excited in a reverse direction, producing in the armature an e.m.f. to assist the battery e.m.f. This field excitation is continuously varied to make the armature voltage always equal to the difference between the battery and line voltages.

As to which is the better method is an open question, and as Sir Roger de Coverley of sainted memory once remarked, "A great deal may be said on both sides." The efficiency of the end cell system is higher than that of the booster-controlled battery, as there are no losses on discharge other than those in the battery itself, while with booster control there are the additional losses of a continuously running dynamo-electric machine of considerable size. It must be remembered that the armature must be large enough to carry the maximum discharge current, which generally is high. Therefore, the booster is a large machine with correspondingly large losses. The booster-controlled battery, however, has fewer cells and costs less than the end-cell switch controlled equipment. A discharging booster costs no more than an end-cell switch of equivalent capacity plus a charging booster, which latter is also required with an end-cell system, and as about 12½ per cent. less cells are needed a like percentage of saving in its original cost of the equipment results. Also a proportional reduction in the cost of maintenance is effected. If, however, the energy to drive the booster be considered as being supplied by the battery, larger cells will be required, which bring the cost of the booster-controlled equipment up to nearly the same cost as that of the end-cell switch controlled system and a new basis of comparison is obtained. Like nearly every other engineering question this one is solved by determining which system will give a definite service at the least annual cost, inclusive of interest on the initial investment. For most cases it appears that the booster control is the preferable one, but no general rule can be laid down which covers all possible cases, in which this differs in no wise from other engineering problems.

THE YEAR IN POWER TRANSMISSION.

We have noted during the past year the inauguration of many new plants, but there has been in them little of startling novelty. Being a Presidential year, it has been an auspicious period for floating large enterprises. It was a curious psychological phenomenon, this dullness during a period of prosperity in the face of an election that was almost a foregone conclusion. Whatever the cause, the fact was much in evidence. From an engineering standpoint, there was likewise very little of a striking character. The methods and apparatus of the art are substantially unchanged from the standards of a year ago. Even the St. Louis Electrical Congress failed to produce anything of great importance, although much of interest. It is quite apparent that the good old question of insulators is still the one thing of most importance. Some progress has been made in the scientific study of insulators and in the *rationale* of their design, but the fact remains that if one seeks for an insulator that will serve for a pressure much above 50,000 volts with anything like a factor of safety that would be considered adequate in other engineering work, he will usually evoke more fervid assertions than insulators. Very good indeed are some of the insulators now in use at voltages between 50,000 and 60,000, but they have no very considerable margin of safety against spilling over in bad weather, and those who know them best would go very cautiously in advising their steady use at, say, 70,000 to 75,000 volts. It is pretty clear that the art of insulating apparatus is at present far ahead of the art of line insulation.

The tower construction which has appeared in some of this year's plants has at least the merit of reducing the number of supports per mile of line, which is surely a move in the right direction. Whether in the existing state of insulator design and construction this gain is not secured at the cost of considerably enhanced electrical and mechanical strains upon the insulators is quite another matter. The effect of this construction upon danger from lightning is another thing which will be watched with very great interest. One of the most striking things at the St. Louis Congress was the frank statement by one of the engineers most experienced in high-voltage work, that he had practically abandoned lightning arresters in the ordinary sense of that term, and was using in fact a spark-gap so wide as to be hardly more than a place at which the lines might discharge rather than elsewhere. It is very hard to get a clear idea of the real troubles caused by lightning, since on the long high-voltage lines the ground to be covered is so great that individual occurrences are hard to locate. In fact, one of the kinds of information about power transmission systems most needed is exact knowledge of the degree of continuity of service which is now attained. Taking transmission plants of the larger sort using high voltage on lines 20 miles or more in length, how often is the delivery of energy actually interrupted by trouble on the lines? Except in rare instances little is made public on this point. It is certain that all plants have more or less trouble, although many of them pull through without much inconvenience and may lose the total load very rarely. But what is the present standard of first-class service—say in plants operating at 20,000 volts and upwards?

Probably the most important present tendency in power transmission is the union of several plants in feeding a single great network. The importance of this practice in lessening breakdowns, in economizing conductors and in facilitating the taking on of a large and profitable load, can scarcely be overestimated. The advantages gained are those obtained from a low-tension lighting or power network, but on a colossal scale. Several of the big systems of the West include half a dozen or more power houses, both hydraulic and steam, united so as to help each other out in any emergency. A plant thus constituted cannot be shut down as a whole by any accident. Customers on a single line may be inconvenienced by a break, but that is all. Some of these networks cover so much territory as to include sources of power even from different watersheds, by combining which a certain degree of immunity from irregular flow may be obtained. One can, in fact, by this means gain greatly in regularity of power supply and in the advantages of storage. Projects of this sort have a certain interesting kinship to the great power projects recently developed in England in which a group of steam-driven transmission stations is to supply the market of a whole shire. We took occasion recently to comment somewhat at length upon these plans as showing that might be done by working upon a sufficient scale. To carry out such combinations successfully it is necessary to use some pretty long transmissions at the highest available voltage, so that we come back again to the tough problem of line insulation. There have recently been published some interesting studies of very long transmissions, which we have fully discussed, but we must here point out that with the network idea well developed the need for very long transmissions is lessened, since however great may be the territory covered the average distance of transmission will generally remain moderate, the extreme distances being so little worked that their economy becomes a secondary consideration. The work of the future will, it seems to us, be more in the direction of utilizing all the available natural powers of a region than in carrying out great projects involving the delivery of power over hundreds of miles. Certainly from a practical standpoint, in our own country there is a vast amount to be done before engineers will have to tackle the gigantic. And the rapidity with which work goes forward depends more upon that little line insulator than upon anything else—may it soon be perfected!

THE ELECTRIC RAILWAY.

The one conspicuous and brilliant achievement in electric traction during the past year has been the completion of the Subway in the metropolis. Of this in its various bearings we have already spoken somewhat at length and with full appreciation. We need only add here that from the operative standpoint the Subway has thus far in every way fulfilled the hopes of the public. It is a distinguished success and will make the year memorable in the history of the city. The expansion of general electric railway work has been notable, particularly in the line of interurban work, which has indeed been for several years past the active field in electric traction. To tell the truth, so far as urban tramways are concerned, there is precious little left to conquer in the way of building. Extensions and replacements on a moderate scale make up the sum total of tramway building. In the interurban business, however, things are moving, and the networks stretch further and further until one wonders where they are likely to stop. It is quite noticeable, too, that these interurban lines have been undergoing considerable consolidations, so that from the chaos of scattered construction something like coherent systems are beginning to emerge. This is a most fortunate tendency, for through it the interurban lines are certain to rise to a higher plane of usefulness. Until they learn the lesson that the steam roads learned fifty years ago, and work as traffic systems instead of following the principle of every one for himself and Devil take the hindmost, they cannot do the great work that we expect of them.

We had hoped ere this that we might be able to add to the year's successes the triumphant test of a first-class interurban road equipped with the new series alternating motors of which we have been hearing so much. It is so excellent a thing to have an alternating motor with all the conspicuous virtues of a direct-current series motor plus those peculiar to itself, that we must confess to a sense of disappointment that is ill assuaged by the cheerful announcement that several equipments are now nearly ready and will soon be put in commercial operation. We have no doubt of the correctness of the statement, but we want to see the wheels go around and we shall not be happy until we do. It seems to be a sheer case of hard luck, for we have the most positive assurances from the various engineers engaged in the development that the motors are all right and singularly well adapted to certain cases of electric traction—which, we hope, they will soon succeed in finding. Another year, too, has slipped into the gulf of Time and nothing further has been heard of the hundred-mile-an-hour train that has furnished the "scare" headline of many a popular article. There are plenty of electric trains running at good honest railway speeds, but that is all. The high-speed proposition is simple enough, and perhaps the series alternating motor may help us to its concrete embodiment if all goes well. Whenever anybody really wants to run a train at 100 miles per hour the means are at hand to gratify his desire, which generally subsides to about a third of that speed. The really big thing in the heavy traction line is the evolution of the remarkable New York Central locomotive which we recently described at some length. It is not intended for exceptional speeds, but we fancy it would show some fine capabilities in that direction if necessary.

In matters of general equipment there has merely been a rather unusual amount of minor improvement. Larger and finer cars have been put in service, the tracks have been laid with stiffer and heavier rails, and the roadbeds have been, upon the whole, solider than in the past. We are glad to say that the exceedingly cheap and nasty construction thriftily affected by the promoters of two or three years ago is now out of fashion, and the average road is now built with an eye fixed upon traffic as a possible source of profit. We must regretfully note, however, that there is still great room for improvement in the safety devices used upon interurban roads. The accidents of the past year are not a pleasant subject for contemplation, particularly when one considers that many of them could have been prevented. If people would only realize that a big interurban car running at 25 or 30 miles per hour requires a couple of hundred feet to stop, and may take double that distance if the track is bad, collisions would be fewer. We hope another year will see material improvement in safety appliances and in comprehension of the problem undertaken. In the central-station feature of electric traction there has been a steady increase of power transmission to substations, and also in the use of steam turbines as the prime movers. We have published much data on turbo-generators this year, and we are glad to be able to record, in spite of some accidents, very general satisfaction in their use. The engine builders, however, have not yet gone out of business and promise some surprises ere long. For the coming year we have few predictions to make. We shall probably get a look at the first alternating-current road while the year is fairly young, and shall thereafter watch the performance with great interest in the hope of giving in our first number of 1906 the glowing report which was at the nib of our pen this week. The work on the New York Central will surely yield much of interest before the year is over, and, we hope, will encourage other railway systems to similar improvements. Unless we are misinformed, several railroads are merely waiting for the Central results to make a start. There is much of this big work ahead, but it is slow in getting under way. Aside from this there is little to expect but normal growth and the usual succession of minor improvements.

ALTERNATING CURRENT DEVELOPMENTS.

During the past year the single-phase railway motor has overshadowed every other development in the field of alternating current. In reviewing the progress of relatively recent years one is impressed with the fact that the line of separation between direct and alternating-current work seems slowly to have been disappearing, so that even at the present time the electrical companies which deal exclusively with the one kind of current are indeed few in number. With the extension of city railways to suburban and interurban districts arose the demand for some method of rendering available the advantageous features of high-tension alternating currents for the long-distance transmission of power. This demand was well met by the development of that most excellent machine, the synchronous converter, which served admirably to interconnect the transmission and distribution systems. It has long been appreciated, however, that the proper solution of the railway problem involves the use of an alternating-current motor, and the simplicity of construction and the reliability of service rendered by the polyphase induction motor led many experimenters to hope for its adoption for traction work. Owing to its inherent constant speed characteristics and more especially to the necessity for the use of three conductors in the distributing system, the induction motor has not been found applicable for electric railway operation in this country, although local conditions have caused it to be adopted upon several foreign lines. The few engineers who in former times attempted to produce an alternating-current motor possessing the characteristics of the series machine and requiring only two conductors, met with numerous, discouraging results, owing to the low power factor of operation of such machines as then designed, to the high-frequency current then available and to the destructive sparking when a commutator was employed.

The past year has been an exceptionally active one in the development of the commutator type of alternating-current motors. It cannot be said that the demand for such machines is in any way due to unsatisfactory service rendered by the standard direct-current

motors, but rather to a desire to eliminate the expense and complications incident to the use of alternating current for transmission and direct current for operation. That is to say, the principal advantage to be gained by the installation of the recently developed motor is to be found in the elimination of the synchronous converter substation. It is worthy of note that the type of commutator motor which in this country has been considered most seriously and is being developed most rapidly is the one known longest to electrical engineers. To the memory of previous discouraging results before causes and effects had been thoroughly analyzed, and to the encouraging results obtained from other types of machine, can be attributed to the neglect of the now most promising alternating-current commutator motor. Of the two general classes of commutator motors—the one in which the transformer features are utilized, and the one in which the transformer features are eliminated as far as possible—the latter seems better adapted to general service at the present stage of development. Few indeed are the electric roads which can be equipped so as to operate independently of existing systems, so that the importance of employing a motor capable of use on both direct and alternating-current systems is especially important at the present time. It is not logical, however, to assume that conditions as they now exist will always remain, or that the type of machine best suited for general service must be adopted to the entire exclusion of others possessing more advantageous features for special cases. For combined direct and alternating-current work, the inductively compensated series motor, as now developed, performs well the duties demanded of it.

According to present indications, in the operation of alternating-current railways the final distribution of power must be single-phase, independent of the method of generation. The entire simplicity of control of single-phase switching devices and transmission circuits brings forward also the question of single-phase generation and transmission of power. It can be shown that on the basis of equality of e.m.f. to the neutral point, all alternating-current systems are equally efficient in copper, so that if such basis be accepted for judging the various systems, the single-phase possesses special advantages as to erection, insulation and control. Since, however, in any case the weakest point is the one which determines the strength of the system, the e.m.f. between wires is the determining factor for insulation, and it cannot be claimed that on this basis the single-phase equals the three-phase system as to efficiency of copper. Moreover, polyphase generators are less expensive to construct than single-phase machines. While in many respects the ideal equipment for railway service would be single-phase throughout, it seems more probable that the method of feeding the various sections of the roads from the several phases of the polyphase transmission circuits, as at present advocated and being installed, most nearly meets the demand for railway work.

THE PRESENT STATUS OF TELEPHONY.

In the field of telephony, the last year has seen almost no developments of the startling variety which a few years ago during the evolution of the common battery switchboard, the redesign of the underground cable and the application of modern principles of transmission, followed each other with such rapidity that some engineers were averse to ordering new equipment lest it become antiquated before it could be installed. Nevertheless, the telephone art is by no means at a standstill. This is well illustrated by the budget of patents which issues every week from the Patent Office on switchboards, switchboard circuits and every manner of telephone appliance, by far exceeding in number the patent representation of any other of the electrical arts. Many of the inventions when considered alone, each as a unit, are of a most trivial character. This only goes to show, however, that the present accepted system of telephone apparatus has advanced to a stage where, in general, the "finishing touches" alone remain to be added.

A notable tendency of recent origin is toward replacing of the "full multiple" system by the "partial" system. The ever-increasing number of telephone subscribers has not only reduced the concentration of all the lines of one exchange in one switchboard to a physical impossibility, but in many cities a considerable number of switchboards must be used. With the opening of each additional switchboard, a greater and greater percentage of all calls are for lines connected to a switchboard other than that of the calling party. When the number of switchboards is large, as high as 90 per cent. of the calls must be trunked. Under such conditions the trunking switchboard becomes almost as large as the answering or subscribers' board. Under this condition the multiple of the subscribers' board is useful only in handling the small minority of non-trunked or local calls. Not only this, but the retention of this multiple makes it necessary for the answering operators to differentiate between local and trunk calls and to operate them by entirely distinct methods. In the "partial" system the subscribers' line multiple is omitted entirely from the answering sections, but is retained on the trunk sections, and local calls are trunked to these sections exactly as are calls for other switchboards. The resulting drag on the service is insignificant, because of a comparatively small percentage of calls affected by the change, while the cost and expensive maintenance of practically half of the usual multiple is avoided. This partial system has been used in a desultory sort of a way for many years, but recent indications are that it has at last obtained that recognition which its merits warrant.

When the present methods have attained their full development, if history repeats itself we may expect a sudden revolution in telephone practice. When this will occur and to what end none can say with certainty. Already, however, indications are appearing. For a long time the automatic switchboard systems have been demanding recognition. The early untrustworthy and awkward machines have been gradually improved. The possible limit of line capacity has been increased from a few hundred to ten thousand or more. Here and there an exchange has been installed. The early automatic plants for factory and private use have been supplemented by large city systems. In many cases the service has been found quick and efficient, and many regular subscribers of such exchanges are high in their praises of the operation. There are, however, features of some of the present systems which make the telephone manager and engineer wary of them. They are expensive; they are complicated and appear liable to disorder; the wear of different parts is most unequal; and they are not "fool proof." This last is a most salient defect when coupled with the fact that no machine can supply those little deficiencies of the user, which are taken care of by the human operator in a manner that we scarcely recognize their existence. What is considered by some as an indication of a bright future for automatics is the fact that the Bell interests have recently recognized this system in a small way. Several systems have been invented and patented by Bell men, and not only have automatic switchboards been operated by Bell companies in small towns in a few instances, but these interests have placed a small apparatus upon the market for sale to private users.

A new system, a compromise between the manual and full automatic, and which is deserving of considerable attention, is the semi-automatic. In this system, while to all intents the subscriber automatically selects the desired line, the operator is, however, substituted for complicated interconnecting machinery. As thus far developed, the subscriber in calling automatically forwards to the

central office the desired number. The call is made evident to a switching operator by the lighting of the calling subscriber's lamp, and the lamp of a transfer trunk to which he is to be connected by means of the usual connecting cords of manual switchboards. This process is repeated at the position to which the transfer is made, except that the called subscriber's line is indicated for connection. This system from the standpoint of quick service and little avoidance of annoyance to the subscribers, is most promising, and in some quarters it is already being seriously considered for practical trial.

In the line department the most notable move is the introduction into active and successful service of the Pupin system of loaded lines. A considerable percentage of the long-distance toll lines leading out of New York City have for some months been operating continually upon this system and so successfully has the apparatus been made that the change from the overhead conductors to loaded underground cable was accomplished almost without the knowledge of those accustomed to daily use of these lines. The adaptation of simultaneous telephony and telegraphy has proceeded in a gratifying measure. A number of railroads now have their grounded dispatch wires largely equipped for this dual use, and telephone companies throughout the country are preparing to provide their toll lines with composite apparatus that these lines may be put upon a more profitable basis.

THE QUESTION OF PRIME MOVERS.

No question for the engineer is more fundamental in character or of higher present day importance than that of the prime-mover best adapted to the particular purposes which he may have in view. Aside from hydraulic power which, after all, is applicable in but a small number of cases numerically, the present engineering field discloses three strong competitors for central station practice—the steam and gas engines (reciprocating) and the steam turbine. The gas turbine is yet in an experimental stage, although recent reports from Germany seem to indicate confidence there in its future. In any event, it is not a factor in present day practice and the central station engineer is at least saved consideration of more than three sets of rival claims. Regarding the reciprocating steam engine, the study to which this form of prime-mover has been subjected, in particular during the past twenty years, has definitely established its possibilities and limitations, and further advances must almost of necessity relate to the details of realization, and the extent to which the present well-known conditions for economy can be fulfilled. During the past few years interest has been renewed in the use of superheated steam and in the possibilities of binary vapor engines, these two lines of development having reference to the fundamental problem of steam engine economy. The use of the former, however, has not commended itself to American engineers to the extent which prevails abroad, especially in Continental Europe, and during the past few years the use of superheated steam with reciprocating engines has made but slight progress in the practice of the day, although the possible gain in heat economy for the engine itself is well understood. On the other hand, the binary vapor or "waste heat" engine must still, after generations of experiment, be considered as a curiosity rather than as a factor in the world's work. With reciprocating engines, therefore, it does not appear, in the average or standard practice of the day, that the situation is materially different from what it was a year ago, nor are there indications of marked change or progress for the near future. In short, the evolution of the reciprocating steam engine seems to be drawing close to its ultimate limit.

The chief point of present interest relates not so much to the improvement of the reciprocating steam engine, but rather to the claims of its two rivals, the steam turbine and the gas engine. The former of these prime-movers, while undoubtedly susceptible of vast ultimate improvement in detail, cannot be longer considered as an experiment. It has in a real way "made good," and is now taking its place as a factor in central station practice, and in manner constituting a powerful claimant for serious consideration at the hands of every central station engineer. The steam turbine has entered this field of work on the general claims of superior adaptability to the work, economy of space, reduction in size of electric generators, durability, simplicity and increased economy of operation. Of these various claims the most important is doubtless that relating to economy in terms of heat per unit of power output. Whatever may be the issue of the contest between the steam turbine and the reciprocating engine, it seems clear that the former in order to displace entirely the latter must establish marked improvement in economy of operation. Space occupied is usually not an item of determining importance, the matter of rotative speeds is met by multipolar types of generators, while special troubles due to such speeds form one of the peculiar difficulties with which the turbine must reckon. Again, up-keep and general operative charges are likely to be much the same, and in the end it comes largely to the question of heat economy with the two types of prime-mover.

The facts relating to this point seem to be that many steam turbines under modern conditions, and especially with superheated steam and low vacuum, have displaced older machinery of the reciprocating type and have naturally shown marked gains in economy; also that on test, under such conditions, steam turbines have shown economic results of the same order as the best modern reciprocating engines under similar conditions, or possibly a shade better and with indications of a wider range of high economic conditions as compared with the reciprocating type. In considering record tests of the steam turbine it must be remembered that such tests have been made with steam superheated from 50 to 100 degrees or more, and with about 28 in. vacuum. Results of such tests compared with compound engines using saturated or moist steam of perhaps lower initial pressure and a vacuum of 25 or 26 in., will obviously be unfair to the latter as a type; and further, that while we have now many tests on turbines made under the conditions specified above, we have very few on reciprocating engines made under similar conditions. The quoted differences are, therefore, due in part at least to the difference in the conditions, and it is certain that the apparent economic superiority of the turbine would in large measure melt away if compared with reciprocating engines operated under the same thermodynamic conditions. But admitting that the indications may seem to imply the possibility of a somewhat higher sustained economy, or at least of a more ready attainment of the higher grades of economy with the turbine than with the reciprocating engine, it still remains a fact that, at most, the difference will not be large and can hardly of itself form a determining factor. However the figures for performance may be interpreted, it remains the broad fact that the best steam engine economy and the best steam turbine economy are of the same general order, and that so far as guarantees are concerned, the promises of the builders of one type may be closely paralleled by those of the other. But the turbine in its present form is relatively new; it has the future yet before it, and further improvements may yet be made which will place it incontestably ahead of the reciprocating engine in economy. At the present time, however, the difference under similar conditions is but small, and would hardly form a determining factor independent of such further arguments as may perhaps be developed from simplicity, decreased cost of repairs and maintenance, and higher general commercial efficiency.

From the viewpoint of economy the promise of the gas engine as a rival to the reciprocating steam engine seems to be more charged

with possibilities than that of the steam turbine. So far as direct heat economy is concerned, the superiority is unquestioned, and it has become largely a question of mechanism and of extensions in the sources from which fuel for the gas engine may be drawn. The gas engine may in some cases use a highly refined or specialized type of fuel, such as illuminating gas or gasoline vapor, making the fuel cost excessive when expressed in relation to power output. Taking the field at large, fuel for gas engines is now provided from a great variety of sources—natural gas, illuminating gas, producer and water gas of different grades, and the various forms of liquid fuels from gasoline to crude oil. The lines of progress of the higher present significance are those having relation to gas producers, especially of the so-called "suction" type, and intended for small independent plants; to extensions in the grades of coal available for such purposes, and to the development of engines using crude oil or some relatively cheap form of engine distillate independent of the expensive and cumbersome gas apparatus requiring coal as the foundation fuel. It must be admitted, however, that as a mechanism, and especially with reference to considerations of reliability and readiness of control, the gas engine is distinctly inferior to the steam engine. The gas engine in brief, then, possesses a distinct advantage as a thermodynamic apparatus and at present a distinct disadvantage as a mechanism. But progress and improvement are the order of the day in gas engine practice, and it seems reasonable to believe that if the advances now in hand both as to source of fuel and to mechanical operation can be carried out with such reasonable measure of success as has been met with in other lines of development, the future of the gas engine will be well assured as to its all-around superiority for service as a prime-mover in central station practice.

To sum up, the competition between the reciprocating steam engine and steam turbine seems to turn on heat economics of the same general order, or at best with but slight advantage for the latter, and with markedly different mechanical relations to the work in hand, the choice requiring, therefore, a careful weighing of these various factors as briefly indicated above. With the gas engine the superiority in heat economy is incontestable, and a corresponding saving in the general expense of operation is chiefly a question of improvements in fuel adaptation and in mechanical operation.

ELECTRICAL SCIENCE DURING THE YEAR 1904.

Although no epoch-making discoveries in electricity or magnetism are recorded for the year 1904, there has been a very marked advance both in these sciences and in their practical applications. The marked tendency of thought and investigation has been and is toward the electron theory of electricity. The doctrine of the eighteenth century was that there were two distinct imponderable electric fluids —one positive and the other negative—and that neutrality existed when these fluids existed in equal quantities in a given mass of matter. When the fluids were separated electrification resulted. In the earlier part of the nineteenth century the Franklinic theory seems to have predominated, namely, that there was but a single imponderable electric fluid, that positive electrification was produced by an abnormal accumulation of this fluid, and negative electrification by an abnormal deficiency. Most electrical phenomena were capable of explanation on either hypothesis indifferently, but much debate existed between the followers of the two respective theories. In the latter half of the nineteenth century, however, accumulating evidence was found of an electrical dissymmetry, that could not be accounted for by either hypothesis. Thus the phenomena at the cathode of an electrically excited vacuum tube were found to be characteristically different from those at the anode. Again, a highly heated electric conductor was found to be capable of discharging more readily when negatively electrified than when positively electrified.

These and many other cases of differentiation in the behavior of positively and negatively electrified bodies have given rise in recent years to a return toward the two-fluid electric theory in a new form. It is now believed by many that positive and negative electricity are distinct entities. But they are no longer regarded as all-permeating imponderable fluids. On the contrary, it is supposed that all atoms of matter are built up of numerous corpuscles of positive and negative electricity called electrons. A negative electron is the smallest assumable particle of matter, enormously smaller than an atom, and itself nothing more than a negative electric charge. Its magnitude is supposed to be 1.6×10^{-19} coulombs. Presumably no smaller quantity of electricity than this can exist, and all negative electrons possess just this amount of electricity. One ampere flowing for a second carries a quantity of electricity equivalent to about six million-million-million electron charges. The nature of the positive electrons is not clearly defined as yet. An atom, considered as a cosmical system of whirling electrons, has no resultant electric charge, although in its immediate neighborhood there are supposed to be electric forces due to the proximity of the electrons. When, however, a negative electron is dislodged from an atom, the mutilated atom becomes positively electrified as a whole.

Following this line of presentation, which can only pretend to be a crude description of a very recondite hypothesis, it is evident that a salient difference between the modern two-fluid theory and the old two-fluid theory of electricity is that the electricity is no longer imponderable, but on the contrary has mass. In fact it is because an atom is constructed of electric corpuscles, or electric charges, or electrons, that its mass and inertia become accounted for on the modern theory. The advantage of the new theory over the old is not only in regard to its explaining certain special phenomena connected with electricity, but also because it kills three birds with one stone, and explains simultaneously the inertia of matter, the chemical varieties of matter, and the behavior of electrified bodies. It thus seeks to interconnect mechanics, chemistry and electromagnetism. It is clear that the real value of a physical theory is not so much whether it represents the fundamental truth concerning the universe —for that may be beyond the present reach of human intelligence— but rather whether it accounts for, explains, interconnects and permits of predetermining the phenomena surrounding us. During the past year a number of facts have been correlated with the electron theory, and a number of communications have been made by physicists in support of the theory.

Two interesting corollaries appear to follow from the electronic theory. The first is that the chemical atom, instead of being the smallest assumable entity, becomes a relatively large entity within which the electrons move in orbits with considerable velocities throwing off radiations of heat or of light according to the lengths of the electron year. The year of an electron, considered as the period of its orbit, may be about as much shorter than a second of time as a planetary year is longer. Human beings on this hypothesis have their existence and perceptions about midway between the microcosmic planetary systems of electrons in atomic orbits and the microcosmic planetary systems of worlds in solar orbits, and receive impressions from both. The second corollary is that whenever the electrons are found in large quantities dissociated from atoms, they are likely to behave like gases. Thus, it is believed by some that in the substance of a metal such as copper the number of free electrons wandering about is of the same order as the number of atoms. In a cubic centimeter of zinc it has been estimated that there are 2 followed by 22 zeros of free electrons. On such a hypothesis the atoms of zinc must be immersed in a tenuous gas of electrons, as stars may be immersed in a nebula.

A recent paper of Drude outlines the nature of thermo-electricity and the magnitudes of the Peltier and Thomson effects based upon the theory of swarms of free electrons in metals. Within the last few days the vice-presidential address to the Physical Section of the American Association for the Advancement of Science by Prof. E. H. Hall, offered a tentative theory of thermoelectric force on similar lines. Prof. Hall demonstrates that one of the well-known thermoelectric diagrams of e.m.f. may be properly regarded as equivalent to an entropy—temperature diagram. In order to interpret the diagram on that basis, he shows that electricity may be looked upon as resembling a gas, the molecules of which are attracted to the containing metal with a force which varies with temperature. This and another postulate are shown to be jointly capable of satisfying the thermoelectric circuit and diagram on similar lines to thermodynamic circuit and diagram. The idea suggested appears to be in general conformity with the modern electron hypothesis, but is in direct opposition to views held a few decades ago. At that time it was taken as an axiom that there could be no free electricity within a conducting mass, or that all the electricity must reside on the surface. Now it is taken for granted that there may be huge numbers of free electrons in the mass of a conductor, each with its inseparable electric charge, and, moreover, the entire atomic structure of the mass is now supposed to be built up of electrons or electric charges. Prof. Hall informs us, however, that he is not at all satisfied as to the tenability of his theory.

The phenomena of radioactivity, which have also received a large share of attention in the last few years, have also recently favored the electron theory. It seems that when radium atoms disintegrate they throw off both material particles and electrons. The electrons are stated to fly off with velocities approaching the velocity of light. According to the known laws of electromagnetism, an electric charge possesses mechanical inertia and the electrons thereby possess inertia. The inertia, however, is not absolutely constant, but is a function of the velocity. For ordinary velocities the inertia is practically one and the same, but as the velocity closely approaches that of light, the inertia rapidly rises, and is said to become infinite at that velocity. It has been suggested that conditions may occur very rarely, say once in millions of millions of electron years, when some particular electron attains in its orbit the velocity of light by a wonderful combination of rare chances. Its inertia suddenly becoming enormously increased, the whole orbital system may be disrupted, and the atom broken up. Such are estimated to be the nature of the disturbances in radium giving rise to radioactivity, and they have been interpreted favorably to the general theory of electrons. The conditions might be likened to the very rare occasions on which worlds or planets come into mutual collision on the macrocosmic scale. The chance of any one world of a planetary system colliding with any other is held to be exceedingly small, nevertheless, in a sufficiently large number of years or ages, the probability might become appreciable, and the collision once brought about might be expected to develop remarkable velocities and disruptive phenomena.

In view of the fact that an electric charge, as for example an electron, is supposed to develop an infinite inertia at the speed of light, and also that radium salts emit a shower of electrons moving at velocities apparently close to that of light, Prof. J. J. Thomson, who has taken so prominent a share in the development of the electron theory, communicated a paper to the International Electrical Congress of St. Louis on the question as to whether the mass and inertia of radium bears the same proportion to its weight that is found in ordinary matter. He tried the experiment of timing a pendulum, the bob of which was a little package of a radium salt. The theory was that if an appreciable portion of the electrons in the radium were always moving at velocities near to that of light, the inertia of the radium might be appreciably increased thereby, and thus the periodic time of the swing of the radium pendulum might be appreciably affected. In other words, the gravitational constant, *g*, of the earth's attractive force might be sensibly different when determined by a radium pendulum, than when determined by a pendulum of lead or other metal. No difference was, however, detected that could not be accounted for by errors of observation, so that if the electron theory is sound it is perhaps to be inferred that only so few of the radium atoms at any one moment possess electrons at very high velocities, as would make no appreciable effect on the inertia of the whole mass.

The great electrical event of the year 1904, from an international standpoint, was the International Electrical Congress of St. Louis, the *Transactions* of which are now in press. The membership of the Congress was about 2050, and the total attendance over 700. Of the 155 papers presented, 100 were printed and distributed among the attendant members, the remainder being read from MSS. The quality of these papers, all of which were prepared at special invitation, and most of which were bespoken half a year in advance of the Congress, was recognized as very high in the directions of both theory and practice; so that the *Transactions,* which will form three large octavo volumes of some 900 pages each, will form a lasting memorial of the status of electrical knowledge and applications at that period. A considerable number of the papers presented were by European authors, and the number of foreign members attending the Congress was large, considering the long distance of St. Louis from Europe both in longitude and in time of travel. This attendance was greatly assisted by the circular tour of the American Institute of Electrical Engineers, carefully planned in advance. The Chamber of Delegates of the Congress arrived at the unanimous conclusion that there are certain differences in electrical units, or the laws relating to them, in different countries, and that an international commission should be appointed to consider the matter. This action, if duly followed up in the not far distant future, should be productive of the best results. It will be some time before we can expect another International Electrical Congress to be convoked. In the past these congresses, of which the St. Louis Congress was the fifth, have done much good work toward international electrical progress. If it had not been for these congresses we might today lack our international electrical units based on the metric system.

The year 1904 has also witnessed the linking of Alaska with the United States, and the rest of the world by permanent telegraphic communication over sea and land. Strangely enough, about half a century ago, a survey was made of an overhead telegraphic line route through Alaska to connect the United States with Asia via Behring Straits. The success of the Atlantic cable was the death blow of the enterprise for more than forty years. If the Atlantic cable had never been laid Alaska might have been the earliest distant territory of the United States to be telegraphically connected with Washington instead of the latest. In general it may be confidently asserted that the year just passed has witnessed marked progress in electrical research, electrical science and electrical applications. Each year sees electrical machinery more widely used, and the knowledge of its use more widespread. There is no longer a barrier between the science and its utilization. A research laboratory is a modern feature in any large establishment for the manufacture of electrical machinery and apparatus. On the other hand, the electrical industry has quickened and stimulated the progress of physics in electrical directions by perpetually opening up new avenues of interesting and profitable research. This community of effort is steadily extending its influence for progress to all the nations of the earth.

Mayor McClellan on a New York Municipal Plant.

A New Year's message from Mayor McClellan to the New York Board of Aldermen deals in large degree with the question of municipal ownership. Part of it is quoted herewith as of general importance to the electric lighting industry:

"I am in favor of municipal ownership and operation of an electric lighting plant to light the streets, parks and public buildings of New York.

"I do not believe that the government should engage in any service which can be done better or as well by private enterprise, or should invade business fields in competition with the legitimate trade of the citizen. Where service rendered by private corporations is unsatisfactory, either because of its inferiority or its excessive cost, it becomes the province of government to take control of that utility for its own uses. The prices which the city is compelled to pay for gas and electric light are so out of proportion with the charges in other cities that they must be extortionate. No relief is in sight, as there appears to be an absence of real competition.

"This matter has received the attention of the Board of Estimate and Apportionment, and at its last meeting, after hearing the opinion of the Corporation Counsel and Judge Dillon, a commission was appointed consisting of Prof. George F. Sever, of Columbia University; Dr. Cary T. Hutchinson, electrical engineer, and Nelson P. Lewis, the engineer of the Board of Estimate and Apportionment, and instructed to report, as soon as possible, general plans and estimates of cost for a municipal lighting plant for the streets, parks and public buildings of the city as a whole, by boroughs and by districts. This project, if decided on, will be greatly aided by the use of the rights reserved in grants heretofore given to the Consolidated Telegraph & Electrical Subway Company and the Empire City Subway Company, and by virtue of which these companies have constructed and now maintain their conduit systems.

"In connection with this subject it is suggested that still another economy may be affected by the utilization of the waste and refuse collected by the Street Cleaning Department, for this, it is urged by competent authority, will very likely generate all the current needed for lighting in streets, avenues, parks, docks and public buildings of the entire city.

"The experience of many cities and towns in England, Ireland, Scotland and Wales has demonstrated that their lighting has been made possible by employing their mixed refuse as fuel for the making of steam, which in turn is utilized in the generation of electric currents. The process calls for well-designed, well-built and intelligently managed destructors. The incinerator used by the Street Cleaning Department in West Forty-seventh Street, where a current is generated for lighting the stable and dock, shows the practical results that are obtained even on so small a scale.

"Data has been furnished showing the very considerable extent to which this method is carried, especially in the cities of England, and the actual product per ton of refuse. The Borough of Woolwich, in London, has recently established a destructor and in connection with it a complete electrical equipment, which is in practical operation. Brentford, with one small destructor, erected four years ago, and burning only fourteen tons of refuse in twenty-four hours, pumps 600,000 gallons of sewage in that time, besides supplying light to the stable and plant. Gloucester lights its streets with its waste, using no other fuel. Liverpool utilizes its refuse in the same way. In Sheerness the destructor plant is within eight feet of a public school, and is so inoffensive as to cause no complaint.

"There are scores of illustrations in Great Britain of the successful operation of these plants. With 5,500 tons of refuse gathered daily by the Department of Street Cleaning—twice the per capita quantity collected in London—New York has a power-producing fuel that should be used profitably. It would seem feasible, therefore, to settle two propositions at the same time—that of municipal lighting and that of utilizing the city's waste as fuel for the generation of electricity. The subject is an interesting one and it is hoped that it will receive careful consideration by your honorable body."

A further part of the message deals with the deficient water supply now furnished under municipal management, and in proposing a special commission for needed new work, the Mayor says: "The act creating this commission should enable it to so plan its work as to utilize the energy that may be developed from the water power. Since we are at the disadvantage of taking our supply from distant watersheds and piping it down from the higher levels up state, the water should be made to earn its own passage. Experts have estimated that many millions of horse-power may thus be created and put to many uses to bring revenues to the city. Only an insignificant part of this power, for example, would be needed to provide the energy to light the city with electricity."

Opening of the Boston Tunnel.

Boston had a useful Christmas present in the shape of the East Boston Tunnel, which was opened for traffic on December 30. The first car to carry paying passengers was run over the new route from the Maverick Square portal, and throughout the day a heavy business was done, the regular traffic being greatly increased by the number of riders who took the journey from motives of curiosity. The business was handled expeditiously and smoothly by the Boston Elevated Railway Company, and the improvement in transit facilities between the island wards of the city and the mainland was marked. The operating company's preparations to facilitate the movement of passengers at stations and cars through the tunnel reaped a well-deserved reward. Transfers were easily made between the various subway and surface cars and the tunnel, and large numbers of passengers from Winthrop, Chelsea and East Boston availed themselves of the new route to and from their work in the city proper.

Papers have been passed by which the East Boston tunnel has been formally leased to the Boston Elevated Railway Company for 25 years, beginning June 10, 1897, and ending June 10, 1922. Three-eighths of 1 per cent. of the gross receipts of the company from lines owned, leased or operated is specified as the rental, in addition to which the company agrees to act as agent to collect the tunnel toll of 1 cent, or such other amounts as may be fixed from time to time. The proceeds of the rental and toll will be used by the city of Boston as a sinking fund to redeem and pay the interest on the tunnel bonds.

Bostonians believe that in this tunnel they have secured a great addition to their transportation facilities. The tunnel runs from Maverick Square, East Boston, to Scollay Square, in the city proper. The length of the harbor section is 2,700 feet and the depth of earth between the top of the tunnel and the harbor bed is about 20 feet. The minimum of earth over the bore after the harbor has been dredged to 40 feet depth will be about 5 feet. The section under the harbor is said by engineers to be almost perfect, the leakage being only eight gallons a minute, while the leakage in the Mersey tunnel in Liverpool is said to be 8,000 gallons a minute. The tunnel is thoroughly ventilated by means of a duct that runs through the upper part of the bore connected with ventilating fans, motor driven.

Philadelphia Meeting of the American Association for the Advancement of Science.

The fifty-fourth annual meeting of the American Association for the Advancement of Science was held at the University of Pennsylvania, Philadelphia, December 28-31, together with meetings of more than a score of affiliated societies. Dr. William G. Farlow, of Harvard, presided. Col. Carroll D. Wright, former Commissioner of Labor, as retiring president, delivered the presidential address, his theme being "Science and Economics." Though the gathering was a good working one, the registration was small, and no list of members in attendance was published, as has always heretofore been done. The shrinkage in attendance is ascribed to the absence of a large contingent which has been attracted to many previous meetings by social features. While perhaps not more than 700 or 800 were in attendance at once at the various meetings, the interest manifested in the programme was unusually lively. Much stress was laid on this in the section of Social and Economical Science, where the excellence of the papers was commented on by several members as the highest by far that had ever been attained, and the unusual step was taken of passing a vote of thanks to the officers for providing so excellent a programme.

The programme of the section of Physics, supplemented by that of the American Physical Society, was perhaps equally commendable. Prof. E. H. Hall, of Harvard, delivered the presidential address to the sections as its retiring vice-president, an abstract of which follows. The paper of Mr. Bergen Davis, of Columbia University,

on "Electrical and Gravitational Forces," and that of Mr. A. D. Cole, of the University of Chicago, on "Thermo-Electric Receivers," are printed in full elsewhere.

At a joint session of Sections D and I, Prof. Alex. E. Outerbridge, Jr., read a paper on "Specialization in Manufacturing," in which he maintained that the trend of the age is toward the abandonment of the old-fashioned factory, equipped for many different products, and the substitution of factories for a single product, even for an incomplete product, as in the manufacture of automobiles—many factories making only one part each and the complete automobile being constructed elsewhere by the assembling of parts collected from many places. This results in making men expert in one line at the expense of rendering them not all-around machinists or mechanics, which defect is now remedied in some large establishments by schools of apprenticeship. The secret of success of American manufacturers lies in the one word, "Scrapping," i. e., sending to the scrap heap machinery which is superseded by improved machines, which in the rapid progress of invention sometimes has to be done even before a new plant is used at all. A striking illustration was cited of an expensive plant for making aluminum by the sodium process, which had to be abandoned before being used, because of the discovery of the far cheaper electrolytic process.

Dr. Calvin M. Woodward, of St. Louis, who has been vice-president of the Economics and later of the Mechanical Section, was elected president of the association for the ensuing year.

Among the vice-presidents elected for the various sections were the following: Section A, Mathematics, Dr. W. S. Eichelberger, of the United States Observatory, Washington, D. C.; Section B, Physics, Prof. Henry Crew, of Northwestern University, Evanston, Ill.; Section C, Chemistry, Dr. C. F. Mabery, of the Case School of Applied Science, Cleveland, Ohio; Section D, Mechanical Science and Engineering, President F. W. McNair, of the Michigan School of Mines, Houghton, Mich.

Dr. Leland O. Howard, chief of the Bureau of Entomology, Department of Agriculture, Washington, D. C., was elected permanent secretary; Prof. Clarence A. Waldo, of Purdue University, Lafayette, Ind., general secretary; Dr. John F. Hayford, of the United States Coast and Geodetic Survey, secretary of the Council, and Prof. R. S. Woodward, president of the Carnegie Institute, Washington, D. C., treasurer.

The association decided to hold its next meeting at New Orleans beginning December 29, 1905. Boston was recommended as the meeting place for 1906.

Below are given abstracts of such papers as were available for this purpose.

CATHODE PHENOMENON.

Prof. Clarence A. Skinner, of the University of Nebraska, presented a paper before the American Physical Society, which met in conjunction with the A. A. A. S., entitled "The Evolution of Hydrogen from the Cathode in Gases at Low Pressure."

Hydrogen is given up by metals generally when used as cathode in gases. In helium, with which the hydrogen does not combine, this property has been found common, without an exception, to the ten different metals tested. By measuring the increase in pressure of the gas and the volume of the containing chamber, the rate of evolution of the hydrogen with the current was measured for three different metals, namely, silver, magnesium and aluminum. With fresh cathodes the quantity of hydrogen appearing in the discharge tube is (within experimental errors) the same as that liberated at the cathode of a water voltameter imagined to be in series with the discharge tube. This is independent of the metal used and also of the pressure of the helium. Under a continued discharge, with the current constant, the rate of evolution of hydrogen becomes smaller and smaller, and finally practically vanishes. All these metals do, however, when allowed to rest, say, over night, recover the property of giving up hydrogen without re-absorbing in the meantime any of that already given up, and will, under the same conditions as before, give up the same amount before being depleted. Aluminum and magnesium seem to recover much more rapidly than silver. The silver cathode has been thus depleted six or eight times without showing any sign of reaching an enduring state of depletion. Observations in other gases indicate in all cases this evolution of hydrogen.

The questions arise: (1) With a fresh cathode, does the hydrogen carry the current between cathode and gas? (2) If so, is it, while still in the metal, in the form of negatively charged atoms? (3) Does it play a part in the Thomson effect, contact potential and thermoelectric couples? Finally (4) What part has it played in cathode ray experiments?

ALTERNATORS IN PARALLEL.

Prof. D. S. Jacobus, of Stevens Institute, presented a paper entitled "Angular Displacement of the Revolving Fields of Alternating-Current Electric Generators when Connected in Parallel." The angular displacement of the revolving fields of two alternators when connected in parallel was determined by actual measurements and compared with computed amounts, and the results were found to agree very closely. Large counterweights had been placed on the engines in order to reduce their vibrations. It was shown theoretically that when the generators were coupled together with the counterweights 180° from each other, the angular displacement was about twice what it would have been without the counterweights. The maximum displacement due to counterweight action and to irregularity in the effort exerted on the crank shaft was found by theory to be 3.2 pole degrees and by observation from three to four pole degrees.

The amount of angular displacement was observed to be the same irrespective of the position of the counterweights, but when the counterweights were opposed the displacements occurred every stroke, or about 94 times per minute, whereas when the counterweights were together, or nearly so, the displacements occurred at less frequent intervals, or about 30 to 40 times per minute. As the total displacement of the two fields from their true positions, as observed, was about the same irrespective of the relative positions of the two counterweights, it follows that this displacement was produced as much through governor action as through any variation in the turning effort during a single revolution.

MEASUREMENT OF THOMSON THERMOELECTRIC COEFFICIENT.

Prof. Edwin H. Hall presented a paper entitled "A Direct Measurement of the Thomson Thermoelectric Coefficient in Soft Iron." With the arrangement adopted by Prof. Hall, it was not difficult to detect one-five-thousandth part of a centigrade degree of temperature. Prof. Hall's method was to place two similar iron rods, each about 20 cm. long and 1 cm. in diameter, in the part studied, side by side, with one end of each rod in ice water and the other end in boiling water, and to send a current of 25 amp. from cold to hot in one bar and from hot to cold in the other bar. With this arrangement the current generated more heat in one bar than in the other, and this made the slope of temperature different in the two bars, which difference of temperature slope was measured by the sensitive temperature detecting arrangement above noted. The value of the coefficient as thus determined is 76×10^{-10}.

A TENTATIVE THEORY OF THERMOELECTRIC ACTION.

Prof. Edwin H. Hall, of Harvard University, in his vice-presidential address before Section B, Physics, set forth a tentative theory of thermoelectric action. He pointed out the analogy between the temperature entropy diagram of the steam boiler engine cycle and the diagram representing the Thomson thermoelectric effect. In the latter the sloping line indicating the absorption of heat by the electric current in passing through a metal from a lower to a higher temperature, is analogous to the sloping line which in the former diagram indicates the absorption of heat by the feed water from the condenser in mixing with the hot water in the boiler. The slope of each line implies that the working agent—electricity in one case and water in the other—takes in the particular quantity of heat represented by the area along the line at a temperature below the highest of the cycle, and, therefore, does not make the best possible thermodynamic use of the heat supplied and of the range of temperature available. Similarly, the inclined line indicating that heat is absorbed by the electric current in passing through a metal from a higher to a lower temperature is analogous to the steam cycle which indicates the recovery of heat from the cylinder wall during expansion after cut-off. Finally, the horizontal lines indicating the absorption of emission of heat by the electric current in passing without change of temperature, from one metal to another, are analogous to those horizontal lines of the steam cycle which indicate absorption or emission of heat in the act of evaporation or condensation.

After pointing out the unsatisfactory state of the theory in regard to the Thomson and Peltier effects, Prof. Hall proceeds to develop a new hypothesis. Returning to the comparison of the passage of electricity from one metal to another with the evaporation of water in a boiler, in the latter case two kinds of work are done upon the water—internal and external work. The movement of electricity

across a junction against a difference of potential corresponds to the external work of evaporation, and the query is made, Is there accompanying this movement anything corresponding to the internal work of evaporation? If so, the heat absorbed by the electricity in the movement may be as bad a measure for the difference of potential at the junction, as the latent heat of evaporation would be for the external work of evaporation. It is not absurd, he says, to imagine that there may be some change of state of electricity besides change of potential, and it is possible that we should take account of something like an attraction between electricity and the metals with which it is associated. We are familiar with the idea that attraction or repulsion exerted on the electric charge which ordinary matter may bear is communicated to the matter itself. This phenomenon may be explained by stresses in the dielectric surrounding or penetrating the ordinary matter, but whatever the true agencies may be, they at least stimulate attraction or some physical tie between ordinary matter and electricity.

The problem of the paper is to find, by the use of any reasonable hypothesis, an explanation of the way in which heat drives an electric current around the circuit of electrical metals unequally heated, and the question is asked, Can the metals of a thermoelectric circuit take the functions of valves or the function of gravitation and so determine the flow of electricity at the expense of heat energy?

Referring to the thermoelectric couple in which neither metal has any Thomson effect, but in which there is a tendency of positive electricity from metal 1 to metal 2 at each junction, the thermoelectric force of such a circuit can be accounted for by assuming that metal 2 attracts positive electricity more, and negative electricity less than metal 1, and that both these differential attractions increase or decrease with change of temperature of the *electricity*. It is stated that the assumption of such an attraction with its dependence on the temperature of the electricity and its independence of the temperature of the metal, except as such temperature determines that of the electricity within it, is much less violent than it at first appears, for if there is such a phenomenon as the expansion of electricity, corresponding to the expansion of air or water, this is enough to give both temperature relations required, for the lessened volume density of the electricity at the heat junction of the two metals would imply a diminished tendency of the electricity to pass over to the more strongly attracting metal at that junction; and just as there is no tendency of water to flow by gravitation along an unequally heated pipe if this pipe is horizontal, so there would be no tendency for electricity to flow along an unequally heated homogeneous metal bar unless the heated parts of this bar attract a given quantity of electricity more or less strongly than the cold parts.

Next, considering the case in which the Thomson effect does play a part, this effect can apparently be accounted for by assuming that the metal has a greater attraction for electricity of one sign than for electricity of the opposite sign, and that the difference of these attractions is a function of the temperature of the *metal.* With this condition the electricity of one sign at any part of a homogeneous but unequally heated bar will be subject to a net attraction, exerted by the metal, toward a place of higher temperature or toward one of lower temperature, according as the attraction between the metal and this kind of electricity increases and decreases with rise of temperature of the metal; and the other kind of electricity will be subject to a different greater or less net attraction from the metal, so that a difference of potential would be set up between the hot and the cold part of the bar if the bar were left to itself.

Having assumed that electricity within each metal acts like an expansible fluid, it is natural to assume that the rise of temperature which causes the expansion of the electricity absorbs heat; that is, that there is a real thermal capacity of electricity, or the corpuscles moving with it, which would come to the same thing. Moreover, the attraction assumed to exist between metal and electricity holds the electricity within the metal in a state of pressure; and accordingly we must recognize in the thermal capacity of the electricity a part accomplished against this pressure in the expansion which accompanies the rise of temperature.

After further examination of the Thomson effect, the additional conclusion is arrived at that we can suppose that electricity in its state of compression within each metal obeys the law of a perfect gas. It is added that Drude in his electron theory does apply the gas laws in some particulars to the electrons within metals. If the electricity flows like a perfect gas through a homogeneous solid conductor of uniform cross-section, its velocity at any given cross-section must be, approximately at least, proportional to the absolute temperature of this cross-section. In the case of a fluid moving through small passages the resistance is proportional to the velocity. Accordingly, the conclusion is arrived at that the resistance encountered by the electric stream should he proportional to its velocity; that is, proportional to the absolute temperature at the part of he conductor considered. In pure metals this is the general law of resistance, and the fact that this law fits the explanation in a conception of the electric current formed without any reference to electrical resistance, adds considerable weight to the argument in favor of that conception.

THE ELECTROMAGNETIC THEORY AND THE VELOCITY OF LIGHT.

Prof. Henry T. Eddy presented a paper with the above title, which discusses in detail how, according to elementary theory, the velocities of plane and circularly polarized rays in any optical or magnetically active medium, must be necessarily related to each other. Following is a summary of the conclusions arrived at in this paper:

1. The increase or decrease in the velocity of circularly polarized light observed by Mr. Mills, and previously by Prof. Brace, are perfectly in accord with and a necessary consequence of the elementary trigonometrical equation expressing the propagation of twisted plane polarized light, and the phenomenon is independent of any hypothesis, electromagnetic or otherwise, as to the manner in which the twisting is produced.

2. The equations given by Prof. Rowland to express the propagation of twisted plane polarized light are not suitable for that purpose, for they in fact express the propagation of a uniformly and continuously rotated plane polarized ray, such as is at present unknown to experimental physics.

3. The velocity of a twisted plane polarized ray is so related to the velocities of the right and left circularly polarized rays of which it is composed that its reciprocal is the arithmetical mean of the reciprocals of its components; and the velocity of Prof. Rowland's rotating plane ray is the arithmetical mean of the velocities of its right and left circularly polarized components.

4. The differential equations based on two different electromagnetic hypotheses as to the action of the medium in producing rotation or twisting of plane polarized light in a magnetic field involve an equation expressing the relation of the velocity of this kind of light at zero field to its velocity in the given field. On the hypothesis of orbital motions of charged ions the differential equations show that the field would cause a decrease in the velocity of plane polarized light during the twisting; while on the hypothesis of charged ions having a motion of translation across the field, the differential equations show that the field would cause an increase in the velocity by an amount one-third as great as the decrease just mentioned. This increase or decrease is of the second order of small quantities, and is so minute as to be at present beyond the range of observation, varying as it does as the square of the observed change produced by the field in the velocity of circularly polarized rays.

5. MacCulloch's differential equations involve practically the same decrease of velocity by the medium as those based on orbital motions of charged ions.

6. A moderate amount of absorption in the medium would not practically modify the conclusions true for perfectly transparent media on either hypothesis.

WESTON INSTRUMENT FOR BALLISTIC MAGNETIC TESTING.

Prof. Albert F. Ganz, of Stevens Institute, presented a paper entitled "Experimental Study of the Use of Weston Instruments for Ballistic Magnetic Testing," in which comparisons are given of the permeability and hysteresis curves obtained by ordinary Weston instruments with the curves obtained by means of a slow-period, undamped ballistic galvanometer. It was found that the curves for a laminated iron ring obtained with the ordinary Weston instrument fell about three per cent. below the curve obtained with the ballistic galvanometer, and that the permeability curve for a solid ring fell over 10 per cent. below the curve obtained with the ballistic galvanometer. The cause of this falling below is stated undoubtedly to be that the time of the first swing of the ordinary Weston instrument is too short to take account of all the change in the magnetic flux which occurs. The Weston Instrument Company then constructed a special instrument having a greater amount of inertia and more magnetic damping than their ordinary instruments, and this gave a permeability curve for the laminated ring which agreed exactly with the curve obtained with the ballistic galvanometer. In order to make a direct-reading magnetic flux meter out of this instrument, ten yards of flexible cord were used for a secondary coil and a re-

sistance added to the instrument so adjusted that the instrument would indicate the flux in kilo-maxwells. This maxwell meter has been successfully used in the laboratory of Stevens Institute for obtaining magnetization curves, measuring leakage coefficients, etc.

THEORY OF THERMOELECTROMOTIVE FORCE.

Prof. Charles B. Thwing, of Syracuse University, presented a paper entitled "A Contribution to the Theory of Thermoelectromotive Force." Assuming, in accordance with the electron theory, that the electric current in a metal is due to the displacement of electrons which behave like a gas, it is but a step in the logical order to calculate the change in potential of such a body of electrons when a change in temperature occurs, by the product of the change in pressure into the change in volume. The potential difference was calculated corresponding to a temperature change of 50° C., for each metal in c.g.s. units and reduced to microfarads. The values were calculated on the assumption that the volume coefficient is equal to three times the linear coefficient. The calculated change of potential was found to agree quite closely in the case of some of the metals experimented with. In a previous paper Prof. Thwing had explained thermoelectromotive force as due to unequal differences of the mechanical pressure of cohesion. He states that it is proposed to make direct determinations of the volume coefficient of expansion, particularly of the crystalline metals and alloys in order to put the theory to a more rigid test. The results presented are stated, however, to amply justify the assumptions made and to constitute a definite forward step in the theory of electromotive force.

ALUMINUM ANODE FILMS.

Mr. C. McC. Gordon presented a paper before the Physical Society entitled "The Capacity and Resistance of Aluminum Anode Films," which gave an account of experiments made with such anodes. The voltage of formation and the capacity per square centimeter in microfarads were determined for a number of solutions, and the conclusion arrived at that if the capacity is a measure of the thickness of the film—which there is no reason to doubt—the experiments show that the theory recently proposed by Mott, that the thickness of a film is a function of the valency of the acid radicle of the electrolyte, does not hold. They would also seem to prove that the film is in the main of the same chemical constitution regardless of the electrolyte used. The films formed in a melted mixture of sodium and potassium nitrates have a much smaller capacity than those in water solutions, the capacity not being more than one-twenty-fifth as large.

LINES OF PROGRESS IN ENGINEERING.

Prof. Calvin M. Woodward, of Washington University, St. Louis, took as the topic for his vice-presidential address in the section of Mechanical Science and Engineering, "The Lines of Progress in Engineering," which subject was treated from the popular rather than the technical standpoint. Referring to the heat engine, he said that the future prime-mover will burn, not explode, its fuel in a working cylinder and that the piston will be driven, first by the products of combustion as the volume increases, and secondly by their expansion against a diminishing resistance. He asks, "Will not some one design and construct a combustion engine which shall consume continuously oil and compressed air, thus maintaining a high pressure in a gas chest and driving a turbine with the products of combustion used expansively, as is now done with steam?" He referred in high terms to the Diesel engine, and quoted from a test in which one cent paid for the fuel per one horse-power for four hours and forty minutes. He referred to the great possibilities from great central generating plants established in the vicinity of coal mines and transmitting electrically over large territories the power generated. He looks forward to the day when in St. Louis, for example, all the heating and cooking will be done by gas and all power furnished by electric current or by gas and combustion engines, both gas and electricity coming from gas works and power plants at the mouths of coal mines in Illinois. He predicted the disappearance of the heavy locomotive through the adoption of electric traction, in the latter case each car, whether for passengers or for freight, having its own motor. He advocated applying the bicycle tubular construction to all rolling stock and moving machinery, using tubular axles, tubular spokes, tubular shafts, adding that "tubular everything is to be the law of future construction." Figures are given showing the mechanical and material advantages of tubular over solid shafting. For example, a thin tubular shaft 4 in. in diameter is 7¾ times as strong as a solid shaft 1 in. in diameter which weighs the same per linear foot. Aeronautics was treated at length and a prediction made that aerial navigation will in time become an actuality.

Electrical Engineers of the Times.—I.

E. R. CARICHOFF.

Eugene Russell Carichoff was graduated from Washington and Lee University, Va., as Master of Arts, in 1885. Following graduation he was instructor in French and German for one year at the State Normal College, Florence, Ala., and professor of Latin and Physics for two years at the Central University, Richmond, Ky., where Prof. E. L. Nichols, now of Cornell, was his predecessor in the chair of physics. Mr. Carichoff spent the summer and fall of 1888 abroad in London and Paris, and upon his return to the United States went with the Edison Phonograph Company in its testing department. Later he was given charge of testing electric welding machines and dynamos by the Thomson Electric Welding Company, at Lynn, Mass., and while there devised apparatus for measuring the conductivity of large copper castings. In 1890 he was engaged by the Yale & Towne Manufacturing Company to apply electric motors to cranes and hoists, and later spent some time in Virginia in the

E. R. CARICHOFF.

designing department of a manufacturing company and in making typographical surveys and maps. He then took up the post-graduate course at Johns Hopkins University as an applicant for the degree of Ph.D. in physics. While at Johns Hopkins Mr. Carichoff devoted most of his time to electrical engineering, and at the end of two years he received, in 1893, the certificate at that time given for electrical engineering work.

While connected with the Johns Hopkins University, Mr. Carichoff planned and superintended the construction of the water power plant of the Lexington (Va.) Light & Power Company, and did special work in electric traction under Messrs. Sprague, Duncan and Hutchinson. Among other things, he designed a model showing the feeders and trolley wires of the Baltimore Traction Company's lines, on which the model cars representing the system were arranged to take predetermined currents; by means of this model the feeders were disposed so as to require the minimum weight of copper to meet the specifications concerning the maximum allowable drop of potential. He also built the apparatus used in tracing alternating current curves according to the method of Dr. Louis Duncan, and prepared the data relating to this method.

Instead of taking the third year at the university necessary to receive the degree of Ph.D., Mr. Carichoff accepted a position with Mr. F. J. Sprague, who was then developing the electric elevator. Shortly after coming to New York he was placed in responsible charge of the electrical department of the Sprague Electric Elevator Company, where his duty was to design controllers and motors for elevators, to superintend their construction in the factory. He also superintended the installation of the earlier apparatus. During this period Mr. Carichoff devised many of the details related to elevator controlling apparatus, and designed a new system of automatic house elevators and its controlling apparatus, which system was adopted by the Sprague company and became standard practice.

Mr. Carichoff was in responsible charge of the design, construction and testing of all the controlling apparatus pertaining to the multiple-unit system of operating electric cars, devised by Mr. Sprague, in which he incorporated many ideas resulting from his previous work with elevator controlling apparatus. He was engaged as engineer of the Otis Elevator Company in 1900 and also retained as consulting engineer in connection with railway work by the Sprague Electric Company, and later by the General Electric Company. During this engagement he designed a number of new controllers for elevators, including the apparatus for the very extensive elevator plant in the Government Printing Office at Washington, D. C. He has assigned to the Otis company a number of patents on elevator controllers, and to the General Electric Company a line of patents on multiple-unit control. In addition to the above engagements, Mr. Carichoff also does a general consulting engineering business.

CURRENT NEWS AND NOTES.

MR. E. KILBURN SCOTT, of London, has been called to the chair of electrical engineering of Sydney University, New South Wales.

NEW YORK ELECTRICAL CONTRACTORS.—The next meeting of the Electrical Contractors' Association of New York State will be held at Troy, N. Y., January 17. Mr. F. Fish, of Rochester, N. Y., is secretary of the association.

CONNECTICUT TROLLEYS.—The report of the Railroad Commissioners of Connecticut shows that for the year ending June 30, 1904, the gross earnings of the street railroads were $34,924,151.46, being $420,580.17 more than for the preceding year.

INDUSTRIAL CAPITAL.—The *Journal of Commerce* reports the total capitalization of industrial companies consolidated during the year 1904 as $185,000,000, compared with $430,000,000 in 1903; $1,122,000,000 in 1902, and $2,800,000,000 in 1901.

PULSATIONS FOR PIKE'S PEAK.—Mr. G. Simmons, of Kenosha, Wis., who owns a steel tower on the top of Pike's Peak, has granted permission to the American De Forest Wireless Telegraph Company to use it for an experiment station, and elaborate preparations are being made.

MR. GISBERT KAPP, general secretary of the German Association of Electrical Engineers, and editor of the *Elektrotechnische Zeitschrift,* has been appointed Professor of Electrical Engineering at the University of Birmingham and will enter upon his new duties in the autumn of this year.

FRENCH SINGLE PHASE ROAD.—At Nivelles (Nord) a trolley line of 20 km. is to be installed; proposals have been asked for a single-phase system. A number of proposals for a three-phase installation have been refused on the ground of the complexities of such a system. In the meantime a part of the line has been put into operation with steam locomotives.

POSTAL WIRELESS IN ENGLAND.—Beginning on January 1, the British Post Office will accept at any telegraphic office in the United Kingdom wireless telegraph messages for transmission to ships at sea. The charges will be thirteen cents a word. The concession is the result of two years of negotiation, toward which the Post Office was at first very cold.

MERGER OF POWER PLANTS.—The proposition to consolidate the light and power plants at the several navy yards, which was recommended by Stone & Webster, experts employed to investigate the matter by Secretary Morton, has received the indorsement of a number of chiefs of the navy department and commandants of navy yards. The Secretary will wait until all report before he reaches a final decision.

FAILURE OF MUNICIPAL PLANT.—Municipal ownership has proved a dismal failure in Afton, Iowa. The electric light plant, formerly owned and operated by the city, has been sold and will be dismantled and taken elsewhere. The price received for the dynamos, boilers, engines and wires is $1,000. The original cost was upward of $6,000. Thus ends one of the most costly experiments ever undertaken in Afton. The plant has been a white elephant on the town ever since it was purchased. Year after year it has drained the city treasury dry, while the service steadily became poorer and poorer, and about a year ago ceased altogether.

MR. FRANK H. MASON, who for some years has been consul-general at Berlin, Germany, has been transferred to Paris and will be succeeded at Berlin by Mr. John L. Griffis, of Indianapolis, Ind. The admirable manner in which Mr. Mason currently reported industrial development in Germany has rendered his name familiar to the readers of American technical and trade journals. According to newspaper report, his successor desired the opportunity for study which a consular post affords in order to write a life of Ex-President Harrison, and obtained the appointment to Berlin as a reward for political campaign services. If he endeavors to keep up the work of Mr. Mason the biography will probably remain unwritten.

THE WESTCHESTER THIRD RAIL.—The New York, Westchester & Boston Railway Company has retained William Barclay Parsons as its chief consulting engineer. Mr. Parsons has just resigned as chief engineer of the Rapid Transit Commission. The franchise of this company calls for the construction of a road practically similar in equipment to the present Subway system of the city, and it is believed by the financial interests connected with the Westchester enterprise that Mr. Parsons' experience in building the city's subway, coupled with his great executive and engineering ability, will make him of particular value to this corporation, as well as insure the construction of the most improved type of railroad.

NEW YORK LIGHTING.—Comptroller Grout, of New York, has tried to prove high charges for lighting for the city by the New York Edison Company by giving figures for some 70 or 80 scattered buildings, at an average of 11 and 12 cents per kilowatt-hour, as compared with a schedule of 4 cents to large consumers. The fact was carefully forgotten by the Comptroller that the low rate quoted is offset by the use of a large portion of real estate conceded by the customer to the Edison system for a sub-station. At Albany Assemblyman Tompkins has introduced the Mayor's bill, prepared by Corporation Counsel Delany, the object of which is to enable the City of New York to construct and operate a municipal lighting plant or plants. Senator Page introduced a concurrent resolution for the appointment of a joint legislative committee to investigate into the reasonableness of charges for gas and electric lighting in New York City. The Board of Aldermen will probably have a hearing or investigation of its own to offset this.

INSTITUTE ANNUAL DINNER. The annual dinner of the American Institute of Electrical Engineers will be given in the ballroom of the Waldorf-Astoria, New York City, on February 8 and promises to be a most interesting occasion. In view of the recent opening of the Subway, thus adding underground traction to the domain of electricity; the adoption of electric locomotives for their great Manhattan terminal divisions by the New York Central and Pennsylvania Railroads; the equipment of the Long Island Railroad with electricity, and other signal events, the Institute has decided to devote this dinner to emphasizing the triumph of electric traction. A number of pioneers and leaders will be present, an original menu has been designed, and some novel features will be introduced, while the list of speakers includes men of national and international reputation. The dinner will be served for $5 per cover without wine or cigars, and as is usual on these occasions ladies will be present. The participation of the ladies was a feature that elicited Mr. Carnegie's enthusiastic commendation at the famous Institute Library dinner, which he made forever memorable by his million-dollar gift for the United Engineering Building. Notices will be sent to the members forthwith, and it is requested that an early response be made, in order that proper care can be taken of all applications. Over 400 had to be seated at the Edison dinner last year and the attendance in February promises to be equally large.

TELEPHONES AND GROCERIES.—At Springfield, Minn., the Minnesota Telephone Company has rented a building and will open a store under the style of the Pure Food Grocery. This is an attempt to meet and offset the competition of some of the grocery people who have gone into telephony, and who are thus to have the tables turned on them.

NORRTHWESTERN CONVENTION.—The thirteenth annual meeting of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., beginning January 18. As usual, Mr. T. R. Mercein, the secretary and treasurer, has prepared an interesting programme, and a good attendance is expected. A cordial invitation to participate has been issued to all engaged in electrical matters affected by the association's work.

ITALIAN RADIOTELEGRAPHY.—A cable dispatch from Rome of December 26 says: "Experiments with the Artons system of radiotelegraphy have been made between Rome and Sardinia, resulting in a successful demonstration of the inventor's claim that an electromagnetic wave message transmitted by this system cannot be diverted from the point for which it is intended. King Victor Emanuel, who witnessed the test, congratulated the inventor upon his achievement."

ELECTRICAL INSPECTORS.—The electrical inspectors of the country have quietly effected an organization among themselves from which excellent results may be expected. It is to be known as the National Electrical Inspectors' Association. The officers and leading spirits are Messrs. J. E. Coler, of Boston; G. G. Hawkins, of Philadelphia, and J. B. McCarthy, of Boston. A great deal of responsibility falls upon the inspectors as to the standard of electrical wiring throughout the country.

MUNICIPAL LIGHTING AGITATION.—On receipt of concurring opinions from Corporation Counsel Delany and ex-Judge Dillon, that New York City has power under the present charter to erect and operate an electric lighting plant for city use, the Board of Estimate adopted a resolution appointing a commission to draw general plans and specifications with an estimate of the cost of such a plant. The commission, appointed on motion of the Mayor is Nelson P. Lewis, chief engineer of the Board of Estimate; Prof. George F. Sever, of Columbia University, and Cary T. Hutchinson. The Common Council of Boston has passed unanimously an order introduced by Councilman McDermott providing for municipal gas and electric lighting plants in this city. It is necessary that such an order pass the City Council two successive years and secure the approval of the Mayor before it is submitted to the people for action at the polls. This resolution has since been defeated.

FRAUD IN TROLLEY TRANSFERS.—The persistent fraud in trolley transfers in New York seems likely to be checked. James Parker, chief inspector for all divisions of the New York City Railway Company, in prosecuting four cases of men charged with using transfers to which they were not entitled, said last week that he had discovered a system in a big department store among the employes of exchanging and repunching transfers to such an extent that fully $1,000 a day was lost to the railway company. "A certain department store in this city," Inspector Parker said, "where hundreds of girls are employed, has a system among its employes which enables every girl to go to and from her work for five cents. Girls coming from up town change their transfers with the girls coming from down town, and one girl has a punch and changes the time. A certain other department store in this city last week discharged an old-time employe because she had been caught repunching transfers for girls in the store."

ELECTRICITY IN COTTON MILLS.—An article in the New York *Evening Post,* discussing the advantages of electric power in cotton mills says: "The use of electricity in factories of to-day effects an economy most where it is possible to cut off many of the machines that are only in use part of the time. While it is true that fewer individual machines are thrown out of use in textile fabrics than in most other plants, it is a mistake to suppose that their operation is continuous. In the best and newest electrically operated cotton mills it has been found that economies can be obtained by stopping some of the machines until others catch up with the work. It is almost impossible to keep the work of all departments running evenly so that the finished goods will come forth without a hitch of any kind. Automatically registering meters show that the amount of power used in a cotton mill varies from 20 to 40 per cent. during the course of each day. The result of this is that direct economy of power, which was barely realized before, is obtained in a cotton mill electrically installed. Another saving has been an increased production by running the machines at higher speed. Moreover, a breakdown in a cotton mill is a serious matter, and in the past many large mills have been kept idle for days and weeks through the breaking of some line shaft or small part of the machinery. The electrically operated mill saves any such loss of time. The breakdown is confined to only a small part of the mill. Each section is run independently, and the work is never stopped more than for about half a dozen machines belted on one line shaft."

GAS AND ELECTRICITY.—We spoke last week of American arc lights being superior to those seen abroad. The London *Lancet* confirms this in the following quotation, although it is a matter of surprise to find a medical journal of reputation so utterly oblivious to the hygienic superiority of the electric light. In this country electricity does not have much trouble holding its own against gas: "The incandescent mantle has saved the gas industry, and not only saved it but placed it in such a position that gas lighting by modern methods of high-pressure incandescence, inverted burners, and so forth, threatens to outstrip electricity for general lighting purposes. This is no exaggeration when we reflect that invariably the finest streets in the great cities of Europe are now lighted with incandescent gas burners, and if the high-pressure incandescent lamps be compared with the electric arc lights at some of the busy street crossings in London there can be no question of the great superiority of the incandescent gas system. In fact, in several places the electric arc lights may as well not be in use in the face of the brilliant penetrating light of the incandescent mantle. This week at a gas exhibition held in the exhibition buildings at Earl's Court, may be seen incandescent gas burners working under pressure with the light of which the electric arc light cannot compete with the brilliancy, steadiness, penetrating power or tone. Nor is it on the large scale alone that gas is seriously rivaling electricity. The inverted incandescent gas burner is hardly distinguishable in appearance from the incandescent electric light in the artistic lighting of domestic rooms."

TELEPHONIC MANNERS are discussed by the New York *Times* as follows: "More than once attention has been called in this column—and shall be once more—to a most irritating form of discourtesy which "came in" with the telephone and from present indications seems likely, unless its too patient victims rise in defense of their rights, their time and their temper, to continue through a long future, to which it will add a wholly unnecessary gloom. We refer to the brutally inconsiderate habit so many people have of causing the person with whom they wish communication to be called to the telephone by an underling, only to hear, when he gets there and announces his identity, a peremptory order to "Hold the wire and wait a minute." Often the minute is a long one, and it always seems so, but after a while, when the man at the other end of the wire finds it quite convenient, the indignant listener hears a suave inquiry as to who he is, and then the business in hand—almost always the caller's business—at last begins. In all such cases the man who is under every obligation of politeness and decency to make things as easy as possible for him with whom he desires conversation has saved himself inconvenience and deliberately put it on the other fellow. The only thing for the other fellow to do when he has been thus outraged is to say, in turn, "Hold the wire and wait a minute," when the man who called him up is ready to tell what he wants, and then to keep that unmannerly one fretting at his telephone at least twice as long as the first delay. Of course, the adoption of this plan involves the loss of more time by the man who shouldn't have been compelled to lose any, but it is a very sweet and satisfying bit of revenge, and once in a while it has a good effect upon the boor upon whom the punishment in kind is inflicted. For it is a fact that a few of the people guilty of this gross imposition are intelligent enough to understand the lesson, after it has been repeated half a dozen times or so, and, realizing the enormity of their offense, they sin no more." It may also be pointed out that this habit helps to delay and congest the system and bring blame on the company and its operators when quite undeserved.

Canadian Niagara Power To-Day.

NIAGARA RIVER sweeps toward the Canadian bank below the Dufferin Islands, and here, about one-quarter mile above the Horse Shoe Falls, the plant of the Canadian Niagara Power Company is located. This plant has been designed on the general lines that have led to such successful results in the two 50,000-hp stations of the Niagara Falls Power Company on the American side of the river. In these two plants, as is well known, the distinct and original features include a wheel pit whose depth approximately equals the height of the falls, turbine water wheels near the bottom of the pit connected by long vertical shafts with electric generators in a power house at the top, and a discharge tunnel through solid rock from one end of the wheel pit to a point in the Niagara cañon near the foot of the falls.

Queen Victoria Park is the site of the entire plant of the Canadian Niagara Power Company, and the arrangement of intake, canal, forebay and power house is most compact. The power house itself, which is nearly 600 ft. long, sets parallel with and about 260 ft. from the river front, where the intake line is located. On this intake line, which is straight, about 350 ft. long, and joins abutments in the bank at its ends, there is an outer ice rack. This rack is partly above and partly below the water level of the river and is supported between the end abutments by eight stone piers. Each section of the rock between piers consists of upper and lower steel beams joined by round iron rods set 2 ft. apart, and each 2 in. in diameter. About 60 ft inside of this outer ice rack, and parallel with it there is a handsome stone bridge of five arches that carries the parkway along the river front, and also the tracks of the International Railway Company. Because of the way in which the natural river currents set toward its bank along the line where the intake piers and rack are located, there is no need of a diverting dam to gather water into the forebay. Moreover, as the river current strikes the outer ice rack at an angle of less than 90° with its upstream end, a cross current is created that sweeps ice along past the face of the rack. No large pieces of ice can enter the canal leading to the forebay because in order to do so it must sink below the rack. At their tops the intake piers are connected by a platform on which persons may pass from one abutment to the other.

After flowing under the bridge arches the water enters a forebay whose floor, like that of the short intake canal, has been reached by excavation in the solid limestone. This forebay rapidly expands from a width of about 280 ft. at the bridge to fully 540 ft. wide at the power house. In this forebay the water is 13 ft. deep at its low level. An extension of the power house runs out over the forebay to a width of about 25 ft., and the water enters this covered portion through archways beneath the outer wall of this extension. These archways do not extend up to the water level, and the continuous stone wall above them causes a cross current along its face that will carry any floating ice to a sluiceway that runs from the downstream end of the wall out to the river. Beneath a part of the power house extension are the stone headgate piers and their connecting platforms. In the spaces between these piers are the gates for the several penstocks, and in front of them is an ice rack. A traveling crane sweeps the entire covered portion of the forebay and the platform back of the ice racks, and is available to lift them. Just inside of each gate comes the upper end of the cast-iron mouthpiece for one of the steel penstocks. Each of these mouthpieces is set in a solid mass of concrete back of the headgate piers and slopes toward the wheel pit, where it joins a penstock. In length the mouthpiece is 30 ft., its diameter at the upper end is 11 ft., and at the lower end it shrinks to about the penstock diameter of 10 ft. 2 in. One of these steel penstocks of 10 ft. 2 in. inside diameter carries water down the wheel pit to each pair of vertical turbines near its bottom. In the completed plant there will be eleven pairs of these main wheels, each carrying an electric generator at the top of its vertical shaft above the power house floor.

FIG. 1.—OUTER ICE RACKS, CANADIAN NIAGARA POWER COMPANY.

Low water in the forebay stands at elevation 516 ft. above mean low tide, and the centers of the wheel cases are 115 ft. below in the pit. About 33 to 50 ft. down from the horizontal centers of the turbines, and 148 to 165 ft. below the water level in the forebay is the bottom of the pit. Each pair of turbines discharges through a single draft tube that runs down below the water level in the pit. This level will, of course, vary with the number of turbines in operation at any one time and with their loads, but its maximum elevation will not exceed 376 ft. above tide water, or 25 ft. below the centers of the turbines. With 25 ft. of draft tube action the total effective head of water on the turbine wheels is 140 ft. The wheel pit has been excavated entirely through rock, partly shale and partly limestone, and is 570 ft. long by 17 ft. 9 in. wide between its side linings. At the lower end of the wheel pit where the tunnel leaves

it to the bottom elevation is 351 ft and the grade toward the upper end is 3 per cent., so that the elevation there is 368 ft. From the lower end of the wheel pit a tunnel 2,200 ft. long, 19 ft. wide and 25 ft. high runs to an outlet in the gorge 400 ft. downstream from the foot of Horse Shoe Falls. The grade of this tunnel is 7 ft. per 1,000, so that its bottom elevation at the portal is about 335 ft. At this point the low water elevation of the river surface is about 343 ft. For a distance of 90 ft. back from its portal the tunnel is lined with granite 2.5 ft. thick, and at the portal itself a granite wall 2 ft. thick and 60 ft. high goes down 30 ft. beneath the lower edge of the tunnel. The tunnel was excavated entirely through shale and limestone rock, and save for its lower 90 ft. of length is lined at the bottom and to a height of 14.6 ft. on the sides with a layer of concrete 18½ in. thick faced with a 4-in. ring of vitrified brick. It its upper part the tunnel is lined first with a framework of 12-in. by 12-in. timbers, and 3-in. lagging, then with concrete and dry backing, and finally with four layers of tunnel brick having a total thickness of 16½ in. Many feet above the portal of the tunnel just described there is the outlet of a much smaller tunnel in the face of the cliff, which discharges water from the power house of the International Railway. Water from this small tunnel will fall down the cliff and join that from the larger one below.

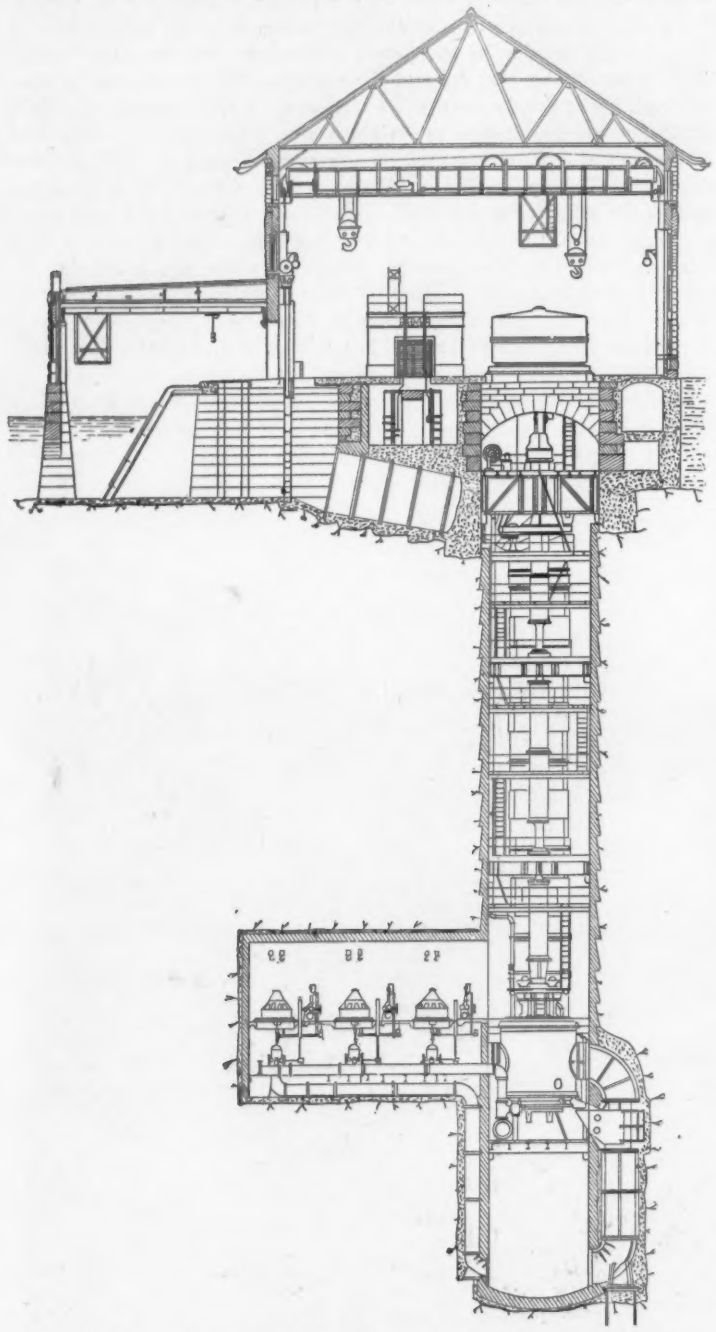


FIG. 2.—CROSS-SECTION OF POWER HOUSE AND WHEEL PIT, CANADIAN NIAGARA POWER COMPANY.

Nearly all of the masonry about the canal and forebay is of granite, and this stone also forms the exterior of the power house and the facings at the top of the wheel pit. The power house itself is distinctly of the steel frame type, the roof trusses over the main portion being supported entirely by steel columns along the sides, and the granite walls carrying little more than their own weight. In general outline the power house is a long narrow building one story high with slanting roof, and with a flat roof extension on the forebay side to cover the ice rocks. The interior width of the main part of the power house is 68 ft. 2 in., and the width of the part that projects over the forebay is 36 ft. 6⅝ in. In length the power house measures about 590 ft. From floor to roof trusses the distance is 41 ft., and the floor elevation is about 522 ft. or 6 ft. above the water level of the forebay. A three-motor traveling crane sweeps the entire main floor of the power house and is supported by the steel wall columns. The center line of the main part of the power house in the direction of its length is parallel with and 12 ft. distant from the center line of the wheel pit over which the power house stands. A masonry arch closes the top of the wheel pit beneath each main generator and the vertical steel shaft that connects each pair of turbines in the generator above the power house floor is guided and supported at three points in its length of about 136 ft. by bearings supported on steel girders that span the pit from side to side. Where this shaft passes through the bearings it is solid with a diameter of 15 in., and in other parts of its length it is hollow with a diameter of 3 ft. 4 in. Beneath the arch that supports each generator there is a chamber in the pit where the governor for the wheels connected to that generator is located. Ten main electric generators thus mounted in a single row over the wheel pit are provided for in the power house, and the distance between centers for these generators is 48 ft. Parallel with the wheel pit and with the row of generators and distant 22 ft. between center lines, are the raised switchboard above the power house floor and the vault for the bus-bars below. As to its length the raised structure that carries the oil switches within and the board for the control switches above is divided into two equal parts, one for each end group of five generators. The walls of this switchboard structure are of brick with glazed exterior surfaces, and each part is about 128 ft. long, 19 ft. 3 in. wide, and stands 11 ft. 6 in.

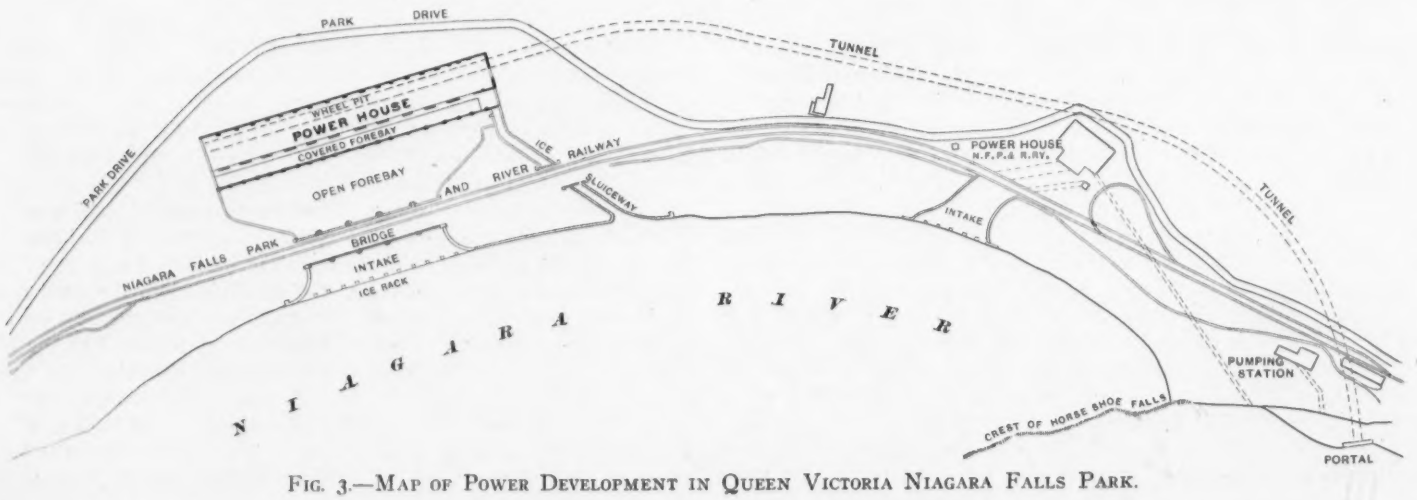


FIG. 3.—MAP OF POWER DEVELOPMENT IN QUEEN VICTORIA NIAGARA FALLS PARK.

FIG. 4.—MASONRY AT PORTAL.

FIG. 5.—MASONRY AT INLET.

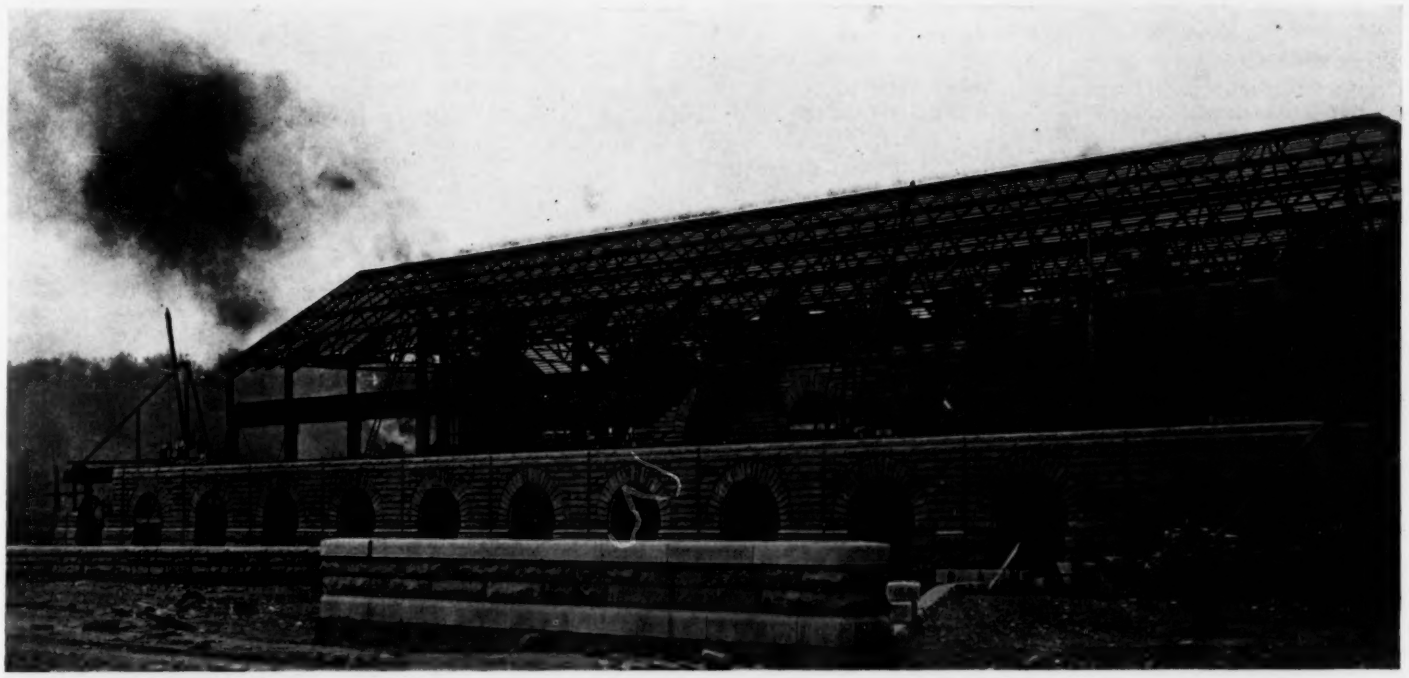


FIG. 6.—GENERAL VIEW OF EAST SIDE OF POWER HOUSE.

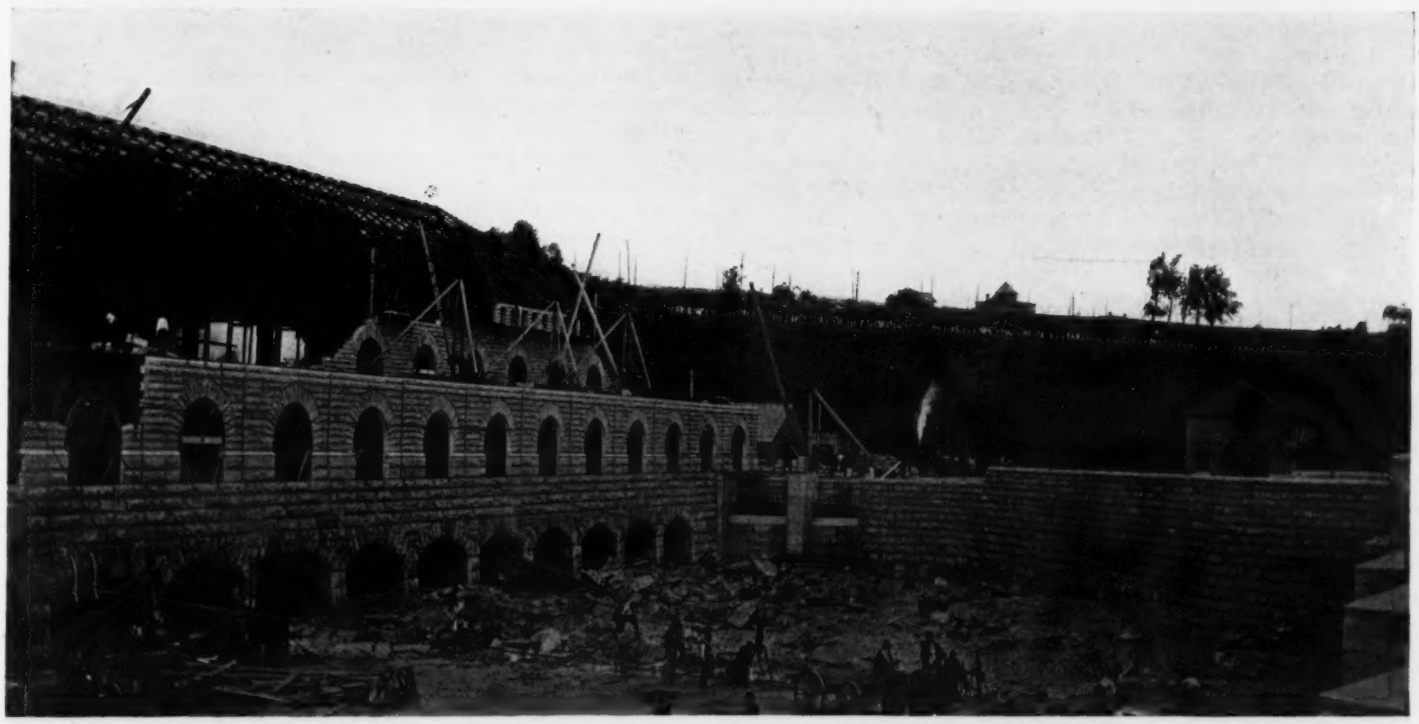


FIG. 7.—GENERAL VIEW ALONG FOREBAY, LOOKING NORTH.

above the floor. The top of this structure forms a raised platform where the control switches for the electrically-operated oil circuit-breakers, the field and exciter switches and those for the lighting and motor circuits about the power house are manipulated. Beneath this elevated switchboard structure there is a vault 16 ft. wide and 11 ft. high for the bus-bar compartments which carry two sets of three-phase bus-bars. A chamber in the rock at one side of the wheel pit and with its floor about 127.5 ft. below that of the power house contains three exciting dynamos direct-connected to their vertical turbine wheels, and also oil pumps for the step bearings. Each exciter turbine takes water through a penstock that branches from one of the main wheel cases and supplies all three. The three exciter turbines also have a common draft tube.

Six exciting dynamos divided between two chambers like that just described are provided for the 10 main generators, and these exciters are rated at 250 kw and 125 volts each. Current from the exciters is used to operate the lamps and motors about the power house. The exciter dynamos are of the Westinghouse make, and each is driven by a single turbine furnished by the Jenks Machine Company. Each of the ten main electric generators is rated at 7,500 kw or 10,000 hp, 12,000 volts, 25 cycles, three-phase at 250 r.p.m., and they are manufactured by the General Electric Company. This will give the plant a total capacity of 100,000 electrical hp. It is estimated that each pair of main turbines will pass about 887 cu. ft. of water per second under full load. Each 10,000-hp generator has an external diameter of 17 ft. and is 12 ft. ¼ in. high above its foundation. The revolving internal magnets are 12 ft. 4½ in. in diameter and the diameter of the vertical shaft is 15 in. The 12,000-volt, three-phase armature is external to the magnets and stationary. As the generator is to give a current of 25 cycles at a speed of 250 r.p.m., the number of the internal revolving poles is twelve. In the 12,000 armature coils the connections are Y. For the revolving part of the generator the weight is 72 tons and the weight of the armature is 85 tons, giving a total of 157 tons for the entire machine.

The selection of 10,000-hp units for this plant reduced the amount of wheel pit area and excavation to a very low figure per horse-power of capacity. Thus the area of the completed pit is 570 by 17 ft. 9 in., or 10,017 sq. ft., and as the total capacity of electric generators is 100,000 hp there is 10 hp to each square foot of area. Development of 12,000-volt, 25-cycle, three-phase currents in the armature windings makes it possible to operate the two plants on the American side of the river and this new one on the Canadian side in parallel without cycle transformation. This voltage so reduces the size of conductors that large blocks of power may be economically distributed to distances of several miles from the generating station without the use of step-up transformers. For the purpose of connecting the Canadian and the American power houses a line of underground conduits has been laid between them by way of the upper steel arch bridge that crosses the river a short distance below the falls.

Between the power house of the Canadian Niagara Power Company and this bridge clay conduits with 32 ducts each have been laid with manholes 400 ft. apart. Each section of clay conduit carries four 3-in. ducts, and four of these sections are laid in pairs in the same concrete shield. Between the upper and the lower pair the distance through the concrete is 9 in., and the width of the concrete shield that carries the imbedded tile is 13 in. The two concrete shields that carry the eight clay conduits with a total of 32 ducts are built in the same trench with a distance of 24 in. between them, the top of each shield is 2 ft. 6 in. below the ground level, and the height of each is 4 ft. 6 in. At its bottom the trench in which these conduits are laid is 4 ft. 8 in. wide and its depth is 7 ft. Along the bottom of the trench and connecting with each manhole there is a clay pipe that runs to the drainage outlet. The manholes with which these conduits connect at intervals of 400 ft. are built in pairs, and only four of the conduits containing sixteen ducts enter each manhole. The ends of the conduits are located at one side of each manhole so that a large free space is left for any work on the cables. A single mass of concrete contains each pair of manholes, but a concrete wall 12 in. thick separates the two. In floor area each manhole is 8 ft. long and 5 ft. wide, and its depth inside is 7 ft. The top dimensions of the concrete masonry that contains each pair of manholes is 10 by 13 ft., the bottom dimensions are 11 by 14 ft., and the height in earth excavation is 8 ft. 4 in. Between the power house and the transformer station, a distance of about 2,000 ft., eight conduits with 32 ducts are laid in the way just described for the conduits to the upper bridge. Disposal of heat is one of the important problems where large power units are transmitted through underground cables, and the conduits have been laid in separate concrete shields in this case so as to give unusually large surface areas for conduction and radiation. The output of each 10,000-hp, 12,000-volt, three-phase, 25-cycle generator at the power house will be carried through the conduits above named by three paper-insulated, lead-covered cables of three conductors each.

To connect the Canadian and American power houses the cables are laid from the bus-bars at the former to the transformer house close to the latter. At this transformer house the 12,000-volt cables will join the high-voltage coils of transformers that are connected in pairs so as to operate between 11,000 volts, three-phase and 2,200 volts, two-phase. The low-voltage coils of these same transformers join the 2,200-volt, two-phase bus-bars in the transformer house. By means of these connections energy generated at either power house can be distributed or transmitted over the circuits leaving the other. Local distribution from the Canadian power house will be carried on directly from the bus-bars there at 11,000 to 12,000 volts, but for transmission to considerable distances the pressure will be raised at the transformer house to 22,000, 38,000 or 57,000 volts by oil-insulated, water-cooled transformers. The transformer station is a one-story brick and steel building located on high land beyond the park limits. In the present station there is room for fifteen transformers of 1,250 kw capacity, and twelve of these with an aggregate rating of 15,000 kw are being installed at once. Each of these transformers occupies a floor space of 58 by 95 in., is 10 ft. 7 in. high, and has a weight of 31,800 pounds. The case of each transformer contains 3,800 pounds of oil. A standpipe 30 ft. in diameter and 116 ft. high is erected outside of the station to supply circulating water for the transformers. The level of water in this standpipe can be drawn down 98 ft., and in that length the pipe holds water enough to supply 30 transformers of 37,500 kw, or 50,000 hp aggregate capacity during 24 hours of operation at full load. The transformers are designed for 11,000 volts primary and for 22,000, 38,000 or 57,000 volts secondary when connected in groups of three. In each of these cases the primary coils are connected delta for the 11,000-volt, three-phase current from the generators. To obtain either 38,000 or 57,000 volts the secondary coils are connected Y form. The facts concerning this plant have been obtained through the kindness of Mr. C. B. Smith, resident engineer.

FIG. 8.—CONSTRUCTION OF CONDUIT.

Shocked to Death in Bath Tub.

A telegram to a daily newspaper from Lima, Ohio, of December 27, says: J. W. Griffin, one of the wealthiest oil operators in the city, and vice-president of the Lima Trust Company, was accidentally shocked to death in his bathroom here to-day. He stood on a register and touched an electric light chandelier with his hands.

The Transmission of Electrical Energy Without Wires As a Means for Furthering Peace.

By NIKOLA TESLA.

UNIVERSAL PEACE, assuming it to be in the fullest sense realizable, might not require eons for its accomplishment, however probable this may appear, judging from the imperceptibly slow growth of all great reformatory ideas of the past. Man, as a mass in movement, is inseparable from sluggishness and persistence in his life manifestations, but it does not follow from this that any passing phase, or any permanent state of his existence, must necessarily be attained through a *stataclitic* process of development.

Our accepted estimates of the duration of natural metamorphoses, or changes in general, have been thrown in doubt of late. The very foundations of science have been shaken. We can no longer believe in the Maxwellian hypothesis of transversal ether-undulations and the literal truth of its corollaries. The practical utilization of electrical vibrations, this most important field of human endeavor, particularly in the advancement of philanthropy and peace, was in no small measure retarded by that fascinating illusion, which I since long hoped to dispel. I have noted with satisfaction the first signs of a change of scientific opinion. The brilliant discovery of the exceptionally "radio-active" substances, radium and polonium, by Mrs. Sklodowska Curie, has likewise afforded me much personal gratification, being an eclatant confirmation of my early experimental demonstrations, of electrified radiant streams of primary matter or corpuscular emanations (*Electrical Review*, New York, 1896-1897), which were then received with incredulity. They have awakened us from the poetical dream of an intangible conveyor of energy, weightless, structureless ether, to the plain, palpable reality of a ponderous medium of coarse particles, or bodily carriers of force. They have led us to a radically new interpretation of the changes and transformations we perceive. Enlightened by this recognition, we cannot say the sun is hot, the moon is cold, the star is bright, for all these might be purely electrical phenomena. If this be the case, then even our conceptions of time and space may have to be modified.

So, too, as regards the organic world, a similar revolution of thought is distinctly observable. In biological and zoological research the bold ideas of Haensel have found support in recent discoveries. A heretic belief in such possibilities as the artificial production of simple living material aggregates, the spontaneous natural creation of complex organisms and willful sex control, is gaining ground. We still brush it aside, but not with pedantic disdain as before. The fact is—our faith in the orthodox theory of slow evolution is being destroyed!

Thus a state of human life vaguely defined by the term "Universal Peace," while a result of cumulative effort through centuries past, might come into existence *quickly*, not unlike a crystal suddenly forms in a solution which has been slowly prepared. But just as no effect can precede its cause, so this state can never be *brought on* by any pact between nations, however solemn. Experience is made before the law is formulated, both are related like cause and effect. So long as we are clearly conscious of the expectation, that peace is to result from such a parliamentary decision, so long have we a conclusive evidence that we are not fit for peace. Only then when we shall feel that such international meetings are mere formal procedures, unnecessary except in so far as they might serve to give definite expression to a common desire, will peace be assured.

To judge from current events we must be, as yet, very distant from that blissful goal. It is true that we are proceeding towards it rapidly. There are abundant signs of this progress everywhere. The race enmities and prejudices are decidedly waning. A recent act of His Excellency, the President of the United States, is significant in this respect. We begin to think cosmically. Our sympathetic feelers reach out into the dim distance. The bacteria of the "Weltschmerz," are upon us. So far, however, universal harmony has been attained only in a single sphere of international relationship. That is the postal service. Its mechanism is working satisfactorily, but—how remote are we still from that scrupulous respect of the sanctity of the mail bag! And how much farther again is the next milestone on the road to peace—an international judicial service equally reliable as the postal!

The coming meeting at the Hague, now indefinitely postponed, can only consider temporary expedients. General disarmament being for the present entirely out of question, a proportionate reduction might be recommended. The safety of any country and of the world's commerce depending not on the absolute, but relative amount of war material, this would be evidently the first reasonable step to take towards universal economy and peace. But it would be a hopeless task to establish an equitable basis of adjustment. Population, naval strength, force of army, commercial importance, water-power, or any other natural resource, actual or prospective, are equally unsatisfactory standards to consider.

In view of this difficulty a measure suggested by Carnegie might be adopted by a few strong countries to scare all the weaker ones into peace. But while for the time being such a course may seem advisable, the beneficial effects of this homœopathic treatment of the martial disease could hardly be lasting. In the first place, a coalition of the leading powers could not fail to create an organized opposition, which might result in a disaster all the greater as it was long deferred. The ultimate falling out of the virtuous, peace-dictating nations, as *certain* as the law of gravitation, should be all the more reckoned with, as it would be extremely demoralizing. Again, it is by no means demonstrated that any combination of a few powers would have sufficient authority.

To conquer by sheer force is becoming harder and harder every day. Defensive is getting continuously the advantage of offensive, as we progress in the satanic science of destruction. The new art of controlling electrically the movements and operations of individualized automata at a distance without wires, will soon enable any country to render its coasts impregnable against all naval attacks. It is to be regretted, in this connection, that my proposal to the United States Navy four years ago, to introduce this invention, did not receive the least encouragement. Also that my offer to Secretary Long to establish telegraphic communication across the Pacific Ocean by my wireless system was thrown in the naval waste basket in Washington, quite *sans façon*. At that time I had already announced in the *Century Magazine* of June, 1900, my successful "girdling" of the globe with electrical impulses (stationary waves), and my "telautomata" had been publicly exhibited. But that was not the fault of the naval officials, for then these inventions of mine were decried as bald, visionary schemes, loudest indeed by those who have since become Crœsuses of Promise—in "light" storage batteries, "Ocean" telephony and "transatlantic" wireless telegraphy, yet remained to this day—Sisyphuses of Attainment. Had only a few "telautomatic" torpedoes been constructed and adopted by our navy, the mere moral influence of this would have been powerfully and most beneficially felt in the present Eastern complication. Not to speak of the advantages which might have been secured through the direct and instantaneous transmission of messages to our distant colonies and scenes of the present barbarous conflicts. Since advancing that principle, I have invented a number of improvements, making it possible to direct such a torpedo, submersible at will, from a distance much greater than the range of the largest gun, with *unerring* precision, upon the object to be destroyed. What is still more surprising, the operator will not need to see the infernal engine or even know its location, and the enemy will be unable to interfere, in the slightest, with its movements by any electrical means. One of these devil-telautomata will soon be constructed, and I shall bring it to the attention of governments. The development of this art must unavoidably arrest the construction of expensive battleships as well as land fortifications, and revolutionize the means and methods of warfare. The distance at which it can strike, and the destructive power of such a *quasi-intelligent* machine being for all practical purposes unlimited, the gun, the armor of the battleship and the wall of the fortress, lose their import and significance. One can prophesy with a Daniel's confidence that skilled electricians will settle the battles of the near future. But this is the least. In its effect upon war and peace, electricity offers still much greater and more wonderful possibilities. To stop war by the perfection of engines of destruction alone, might consume centuries and centuries. Other means must be employed to hasten the end. What are these to be? Let us consider.

Fights between individuals, as well as governments and nations, invariably result from misunderstandings in the broadest interpretation of this term. Misunderstandings are always caused by the inability of appreciating one another's point of view. This again is due to the ignorance of those concerned, not so much in their *own*, as in their *mutual* fields. The peril of a clash is aggravated by a more or less predominant sense of combativeness, possessed by every human being. To resist this inherent fighting tendency the

best way is to dispel ignorance of the doings of others by a systematic spread of general knowledge. With this object in view, it is most important to aid exchange of thought and intercourse.

Mutual understanding would be immensely facilitated by the use of one universal tongue. But which shall it be, is the great question. At present it looks as if the English might be adopted as such, though it must be admitted that it is not the most suitable. Each language, of course, excels in some feature. The English lends itself to a terse, forceful expression of facts. The French is precise and finely distinctive. The Italian is probably the most melodious and easiest to learn. The Slavic tongues are very rich in sound but extremely difficult to master. The German is unequaled in the facility it offers for coining and combining words. A practical answer to that momentous question must perforce be found in times to come, for it is manifest that by adopting one common language the onward march of man would be prodigiously quickened. I do not believe that an artificial concoction, like Volapuk, will ever find universal acceptance, however time-saving it might be. That would be contrary to human nature. Languages have grown into our hearts. I rather look to the possibility of a reversion to the old Latin or Greek mother tongues, basing myself in this conclusion on the Spencerian law of rhythm. It seems unfortunate that the English-speaking nations, who are now fittest to rule the world, while endowed with extraordinary energy and practical intelligence, are singularly wanting in linguistic talent.

Next to speech we must consider permanent records of all kinds as a means for disseminating general information, or that knowledge of *mutual* endeavor which is chiefly conducive to harmony. Here the newspapers play by far the most important part. They are undoubtedly more effective than institutions of learning, libraries, museums and individual correspondence, all combined. The knowledge they convey is, on the whole, superficial anl sometimes defective, but it is poured out in a mighty stream that reaches far and wide. Disregarding the force of electrical invention, that of journalism is the greatest in urging us to peace. Our schools are instrumental, mainly, in the furtherance of special thorough knowledge in our *own* fields, which is destructive of concordance. A world composed of crass specialists only would be perpetually at war. The diffusion of general knowledge through libraries and similar sources of information is very slow. As to individual correspondence, it is principally useful as an indispensable ingredient of the cement of commercial interest, that most powerful binding material between heterogeneous masses of humanity. It would be hard to overestimate the beneficial influence of the marvelous and precise art of photography, nor can that of other arts or means of recording be ignored. But a simple reflection will show that the peace-making force of all permanent, printed or other records, resides not in themselves. It must be sought elsewhere. This is also true of speech.

Our senses enable us to perceive only a minute portion of the outside world. Our touch, taste and smell, require actual contact. Our hearing extends to a small distance. Our sight is impeded by intervening bodies and shadows. To know each other we must reach beyond the sphere of our sense perceptions. We must transmit our intelligence, travel, transport the materials and transfer the energies necessary for our existence. Following this thought we now realize, forcibly enough to dispense with argument, that of all other conquests of man, without exception, that which is most desirable, which would be most helpful in the establishment of universal peaceful relations is—the complete *ANNIHILATION OF DISTANCE.*

To achieve this wonder, electricity is the one and only means. Inestimable good has already been done by the use of this all-powerful agent, the nature of which is still a mystery. Our astonishment at what has been accomplished would be uncontrollable were it not held in check by the expectation of greater miracles to come. That one, the greatest of all, can be viewed in three aspects: *Dissemination of intelligence, transportation, and transmission of power.*

Referring to the first, the present systems of telegraphic and telephonic communication are very limited in scope. The conducting channels are costly and of small working capacity. There is serious inductive disturbance, and storms render the service unsafe which, moreover, is too expensive. A vast improvement will be effected by placing the wires underground and insulating them artificially, by refrigeration. Their working capacity also could be indefinitely augmented by resorting to the new principle of "individualization," which I have more recently announced, permitting the simultaneous transmission of thousands of telegraphic and telephonic messages, without interference, over a single wire. The public would be already profiting from these great advances were it not for the stolid indifference of the leading companies engaged in the transmission of intelligence. But new concerns are springing into existence and the near future will witness a great transformation along these two lines of invention. The submarine cables are subject to still greater limitations. Some obstacles to rapid signaling, through them, seem insuperable. The attempts to overcome these have been numerous, but so far all have proved futile. The celebrated mathematician, O. Heaviside, and several able electricians following in his footsteps, have fallen into the singular error that rapid telegraphy and even telephony through ocean cables would be made practicable by the use of induction coils. Inductances might be to some extent helpful on comparatively short lines with thick paper insulation; on long lines insulated with rubber or gutta-percha they would be positively detrimental. Improvements will, undoubtedly, be made, but great electrostatic capacity and unavoidable loss of energy in the insulation and surrounding conductors will always restrict the usefulness of these delicate and precious nerves of commerce. Apart from all this, the transmission through artificial conductors is necessarily confined to a small number of stations.

It is therefore evident that the abolishment of all these drawbacks by the conveyance of signals or messages without wires, as I have undertaken in my "world" telegraphy and telephony, will be of the greatest moment in the furtherance of peace. The unifying influence of this advance will be felt all the more, as it will not only completely annihilate distance, but also make it possible to operate from a single "world" telegraphy plant, an unlimited number of receiving stations distributed all over the globe, and with equal facility, irrespective of location. Within a few years a simple and inexpensive device, readily carried about, will enable one to receive on land or sea the principal news, to hear a speech, a lecture, a song or play of a musical instrument, conveyed from any other region of the globe. The invention will also meet the crying need for cheap transmission to great distances, more especially over the oceans. The small working capacity of the cables and the excessive cost of messages are now fatal impediments in the dissemination of intelligence which can only be removed by transmission without wires.

The deficiencies of Hertzian telegraphy have created in the public mind the impression that exclusive or private messages without the use of artificial channels are impracticable. As a matter of fact, nothing could be more erroneous. Ever since its first appearance in 1891, I have denied the commercial possibilities of the system of signaling by Hertzian or electromagnetic waves, and my forecasts have been fully confirmed. It lends itself little to tuning, still less to the higher artifices of "individualization," and transmission to considerable distances is wholly out of the question. Portentous claims for this method of communication were made three years ago, but they have been unable to stand the hard, cruel test of time. Moreover, I have recently learned through the leading British electrical journal (*Electrician*, London, February 27, 1903), that some experimenters have abandoned all their own and have been "converted" to my methods and appliances, without my approval and officiation. I was both astonished and pained—astonished at the nonchalance and lack of appreciation of these men, pained at the inability exhibited in the construction and use of my apparatus. My high hopes raised by that excellent journal, however, are still to be realized, for I have ascertained that His Majesty the King of England, His Excellency the President of the United States, and other persons of exalted positions have, after all, not conferred upon me the imperishable honor of graciously condescending to the use of my coils, transformers and high-potential methods of transmission, but have exchanged their august greetings through the medium of a cable in the old-fashioned way. What has been actually achieved by Hertzian telegraphy can only be conjectured.

Quite different conditions exist in my system in which the electromagnetic waves or radiations are designedly minimized, the connection of one of the terminals of the transmitting circuit to the ground having, itself, the effect of reducing the energy of these radiations to about one-half. Under observance of proper rules and artifices the distance is of little or no consequence, and by skillful application of the principle of "individualization," repeatedly referred to, the messages may be rendered both non-interfering and non-interfer-

able. This invention, which I have described in technical publications, attempts to imitate, in a very crude way, the nervous system in the human body. It was the outcome of long-continued tests demonstrating the impossibility of satisfying rigorous commercial requirements by my earlier system, based on simple tuning, in which the selective quality is dependent on a single characteristic feature. In this later improvement the exclusiveness and non-interferability of impulses transmitted through a common channel result from co-operative association of a *number* of distinctive elements, and can be pushed as far as desired. In actual practice it is found that by combining only two vibrations or tones, a degree of privacy sufficient for most purposes is attained. When three vibrations are combined, it is extremely difficult, even for a skilled expert, to read or to disturb signals not intended for him, with four it is a vain undertaking. The probability of his getting the secret combinations at the right moments and in proper order, is much smaller than that of drawing an ambo, terno or quaterno, respectively, in a lottery. From experimental facts, I conclude that the invention will permit the simultaneous transmission of several millions of separately distinguishable messages through the earth, which, strangely enough, is in this respect much superior to an artificial conductor. This number ought to be sufficient to meet all the pressing necessities of intelligence transmission for at least one century to come. It is important to observe that but one "world" telegraphy plant, such as I am now completing, will have a greater working capacity than *all the ocean cables combined.* Once these facts are recognized this new art, which I am inaugurating, will sweep the world with the force of a uragan.

In transportation a great change is now going on. The trolley lines are being extended, the steam locomotive is making place for the electric motor. The ocean liners are adopting the turbine. Land travel is being improved by the automobile. The waterfalls are being harnessed and the energy used in the propulsion of cars. The advantages of first generating electricity by a prime mover, and then applying the current to produce mechanical motion, are being more and more appreciated. To the majority, this may appear a roundabout way of doing, but in reality it is as direct as the driving of a pulley from another by a belt. The idea is already being applied to railroads, and automobiles of this new type are making their appearance. The ocean vessels are bound to follow. An immense and virgin field will be thus opened up to the manufacturers of electric machinery. Effort towards saving time and money is characteristic of all modern methods of transportation. In many of these new developments, the artificial insulation of the high-tension mains by refrigeration will be very useful. However paradoxical, it is true, that by the use of this invention, power for all industrial purposes can be transmitted to distances of many hundreds of miles, not only without any loss, but with appreciable *gain* of energy. This is due to the fact that the conductor is much colder than the surrounding medium. The operativeness of this method is restricted to the use of a gaseous refrigerant, no known liquid permitting the attainment of a sufficiently low temperature of the transmission line. Hydrogen is by far the best cooling agent to employ. By its use electric railways can be extended to any desired distance. Owing to the smallness of ohmic loss, the objections to the multiphase system disappear and induction motors with closed coil armatures can be adopted. I find that even transmission through a submarine cable, as from Sweden to England, of great amounts of power is perfectly practicable. But the ideal solution of the problem of transportation will be arrived at only when the complete annihilation of distance in the transmission of power in large amounts shall have become a commercial reality. That day we shall invade the domain of the bird. When the vexing problem of aerial navigation, which has defied his attempts for ages, is solved, man will advance with giant strides.

That electrical energy can be economically transmitted without wires to any terrestrial distance, I have unmistakably established in numerous observations, experiments and measurements, qualitative and quantitative. These have demonstrated that it is practicable to distribute power from a central plant in unlimited amounts, with a loss not exceeding *a small fraction of one per cent.* in the transmission, even to the greatest distance, twelve thousand miles—to the opposite end of the globe. This seemingly impossible feat can now be readily performed by any electrician familiar with the design and construction of my "high-potential magnifying transmitter," the most marvelous electrical apparatus of which I have knowledge, enabling the production of effects of unlimited intensities in the earth and its ambiant atmosphere. It is, essentially, a freely vibrating secondary circuit of definite length, very high self-induction and small resistance, which has one of its terminals in intimate direct or inductive connection with the ground and the other with an elevated conductor, and upon which the electrical oscillations of a primary or exciting circuit are impressed under conditions of resonance. To give an idea of the capabilities of this wonderful appliance, I may state that I have obtained, by its means, spark discharges extending through more than one hundred feet and carrying currents of one thousand amperes, electromotive forces approximating twenty million volts, chemically active streamers covering areas of several thousand square feet, and electrical disturbances in the natural media *surpassing* those caused by lightning, in itensity.

Whatever the future may bring, the universal application of these great principles is fully assured, though it may be long in coming. With the opening of the first power plant, incredulity will give way to wonderment, and this to ingratitude, as ever before. The time is not distant when the energy of falling water will be man's life energy. So far only about three million horse-power have been harnessed by my system of alternating-current transmission. This is little, but corresponds, nevertheless, to the adding of sixty million indefatigable laborers, working virtually without food and pay, to the world's population. The projects which have come to my own attention, however, contemplate the exploitation of water-powers aggregating something like one hundred and fifty million horse-power. Should they be carried out in a quarter of a century, as seems probable from present indications, there will be, on the average two such untiring laborers for every individual. Long before this consummation, coal and oil must cease to be important factors in the sustenance of human life on this planet. It should be borne in mind that electrical energy obtained by harnessing a waterfall is probably fifty times more effective than fuel energy. Since this is the most perfect way of rendering the sun's energy available, the direction of the future material development of man is clearly indicated. He will live on "white coal." Like a babe to the mother's breast will he cling to his waterfall. "Give us our daily waterfall," will be the prayer of the coming generations. *Deus futurus est deus aquae deiectus!*

But the fact that stationary waves are producible in the earth is of special and, in many ways, still greater significance in the intellectual development of humanity. Popularly explained, such a wave is a phenomenon generically akin to an echo—a result of reflection. It affords a positive and uncontrovertible experimental evidence that the electric current, after passing into the earth travels to the diametrically opposite region of the same and rebounding from there, returns to its point of departure with virtually undiminished force. The outgoing and returning currents clash and form nodes and loops similar to those observable on a vibrating cord. To traverse the entire distance of about twenty-five thousand miles, equal to the circumference of the globe, the current requires a certain time interval, which I have approximately ascertained. In yielding this knowledge, nature has revealed one of its most precious secrets, of inestimable consequence to man. So astounding are the facts in this connection, that it would seem as though the Creator, himself, had electrically designed this planet just for the purpose of enabling us to achieve wonders which, before my discovery, could not have been conceived by the wildest imagination. A full account of my discoveries and improvements will be given to the world in a special work which I am preparing. In so far, however, as they relate to industrial and commercial uses, they will be disclosed in patent specifications most carefully drawn.

As stated in a recent article (ELECTRICAL WORLD AND ENGINEER, March 5, 1904), I have been since some time at work on designs of a power plant which is to transmit ten thousand horse-power without wires. The energy is to be collected all over the earth at many places and in varying amounts. It should not be understood that the practical realization of this undertaking is *necessarily* far off. The plans could be easily finished this winter, and if some preliminary work on the foundations could be done in the meantime the plant might be ready for operation before the close of next fall. We would then have at our disposal a unique and invaluable machine. Just this *one* oscillator would advance the world a century. Its civilizing influence would be felt even by the humblest dweller in the wilderness. Millions of instruments of all kinds, for all imaginable purposes, could be operated from that one machine. Universal time could be distributed by simple inexpensive clocks requiring no attention and running with nearly mathematical

precision. Stock-tickers, synchronous movements and innumerable devices of this character could be worked in unison all over the earth. Instruments might be provided for indicating the course of a vessel at sea, the distance traversed, the speed, the hour at any particular place, the latitude and longitude. Incalculable commercial advantages could be thus secured and countless accidents and disasters avoided. Here and there a house might be lighted or some other work requiring a few horse-power performed. What is far more important than this, flying machines might be driven in any part of the world. They could be made to travel swiftly because of their small weight and great motive power. My intention would be to utilize this first plant rather as means of enlightenment, to collect its power in very small amounts, and at as many places as possible. The knowedge that there is throbbing through the earth energy readily available everywhere, would exert a strong stimulus on students, mechanics and inventors of all countries. This would be productive of infinite good. Manufacture would receive a fresh and powerful incentive. Conditions, such as never existed before in commerce, would be brought about. Supply would be ever inadequate to demand. The industries of iron, copper, aluminum, insulated wire and many others, could not fail to derive great and lasting benefits from this development.

The economic transmission of power without wires is of all-surpassing importance to man. By its means he will gain complete mastery of the air, the sea and the desert. It will enable him to dispense with the necessity of mining, pumping, transporting and burning fuel, and so do away with innumerable causes of sinful waste. By its means, he will obtain at any place and in any desired amount, the energy of remote waterfalls—to drive his machinery, to construct his canals, tunnels and highways, to manufacture the materials of his want, his clothing and food, to heat and light his home—year in, year out, ever and ever, by day and by night. It will make the living glorious sun his obedient, toiling slave. It will bring peace and harmony on earth.

Over five years have elapsed since that providential lightning storm on the 3d of July, 1899, of which I told in the article before mentioned, and through which I discovered the terrestrial stationary waves; nearly five years since I performed the great experiment which, on that unforgettable day, the dark God of Thunder mercifully showed me in his vast, awe-sounding laboratory. I thought then that it would take a year to establish commercially my wireless girdle around the world. Alas! my first "world telegraphy" plant is not yet completed, its construction has progressed but slowly during the past two years. And this machine I am *building* is but a plaything, an oscillator of a maximum activity of only ten million horse-power, just enough to throw this planet into feeble tremors, by sign and word—to telegraph and to telephone. *When* shall I see completed that first power plant, that big oscillator which I am *designing?* From which a current stronger than that of a welding machine, under a tension of one hundred million volts, is to rush through the earth! Which will deliver energy at the rate of one thousand million horse-power—one hundred Falls of Niagara combined in one, striking the universe with blows—blows that will wake from their slumber the sleepiest electricians, if there be any, on Venus or Mars! . . . It is not a dream, it is a *simple feat of scientific electrical engineering,* only expensive—blind, faint-hearted, doubting world! . . . Humanity is not yet sufficiently advanced to be willingly led by the discoverer's keen searching sense. But who knows? Perhaps it is better in this present world of ours that a revolutionary idea or invention instead of being helped and patted, be hampered and ill-treated in its adolescence—by want of means, by selfish interest, pedantery, stupidity and ignorance; that it be attacked and stifled; that it pass through bitter trials and tribulations, through the heartless strife of commercial exisence. *So* do we get our light. So all that was great in the past was ridiculed, condemned, combatted, suppressed—only to emerge all the more powerfully, all the more triumphantly from the struggle.

Steamboat Wiring.

On account of the destruction by fire of the Starin steamboat *Glen Island* which occured recently on Long Island Sound, it is proposed by the Government to adopt a vigorous policy of examination for all steamboats using electricity. Nobody apparently is responsible now, although there are 700 such boats in New York waters and 1,500 in the district from Cape Charles, Va., to Eastport, Me.

A Large South African Motor Plant.

The varied uses to which the electric motor is applicable are well illustrated in the plant of the De Beers Consolidated Mines, Limited, at Kimberly, South Africa, where it has almost entirely dispossessed the steam engine for all classes of work. Several hundred electric motors are now in use in and about the various mines at Kimberly, in shops, etc., and the number is being rapidly increased.

In the central power station, of which the generating equipment will be described later, there are 18 alternating-current motors varying in size from 2 to 50 hp, driving pumps, cooling tower and induced draft fans, mechanical stokers, an air compressor and coal crusher, a coal conveyor and exciter sets. In addition there are three direct-current motors on a crane in the engine room. In and about the De Beers mine there are 45 alternating-current motors ranging in horse-power from 3 to 50, which drive pumps, conveyors, creepers, stamps and crushers, jigs, grease tables, rolls, pans, feed tables, etc., as well as being used for haulage and elevators. At the Kimberly Mines there are eight motors ranging from 3 to 50 hp, driving an arc generator, pumps and ventilating fan. At the Premier Mine there are 12 alternating-current motors ranging from 3 to 50 hp, used for driving an arc light dynamo, for pumping and ventilating. At the Bultfontein Mine there are two motors of 50 hp for pumping

FIG. 1.—BACK OF SWITCHBOARD, SHOWING 5000-VOLT CABLES.

water, a motor of 20 hp operating an air pump and a motor of 50 hp driving a generator.

At the Dutoitspan Mine there are 21 alternating and seven direct-current motors, three of the latter being employed on a crane and four in driving electric locomotives; the alternating-current motors are employed for mine pumping, to operate auxiliary machinery in the boiler house, etc. In the De Beers workshop there are 46 direct-current motors driving machine tools, etc., 22 alternating-current motors driving direct-current generators, a 50-hp alternating-current motor driving an arc generator and two direct-current motors driving electric locomotives. In the town there are 13 alternating-current motors for driving direct-current generators, for running a planing mill, bakery, etc. About two score alternating-current motors ranging in horse-power as high as 125, have been ordered for haulage purposes, running pumps, etc. Most of the motors are of American manufacture, having been supplied by the General Electric Company and the Westinghouse Electric & Manufacturing Company. In addition, almost all of the large European electrical manufacturers have supplied motors to the plant.

The generating plant consists of two 1,250-kw Westinghouse turbo-generators. Very elaborate tests were carried out under the supervision of the late Prof. Thurston before the shipment of these units from Pittsburg. Each set consists of a Westinghouse-Parsons steam turbine, direct-connected to and mounted upon the same shaft with a 5,000-volt, 50-cycle, three-phase, alternating-current Westinghouse generator. Each set is capable of delivering continuously 1,000 kw, with an overload capacity of 50 per cent. for short periods. The speed is 1,500 r.p.m.

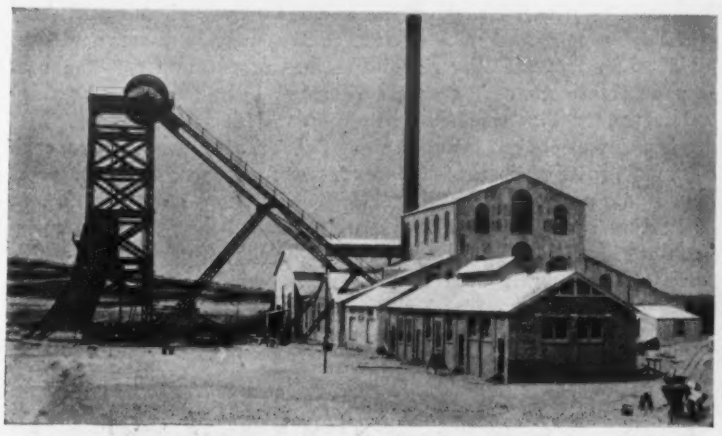


FIG. 2.—ROCK SHAFT, PREMIER MINE.

FIG. 3.—NO. 4 WASHING MACHINE.

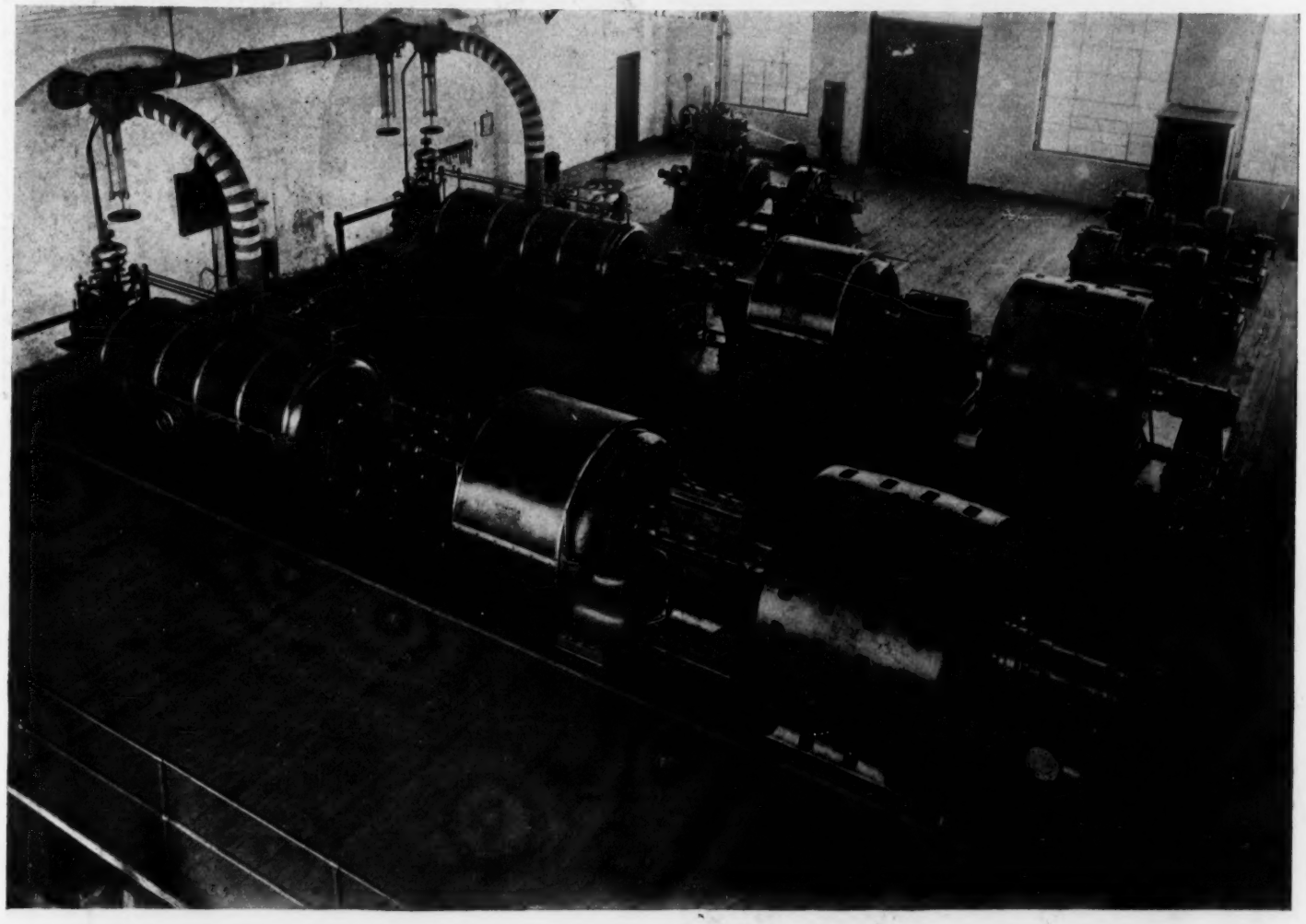


FIG. 4.—1000-KW TURBINES, CENTRAL POWER STATION.

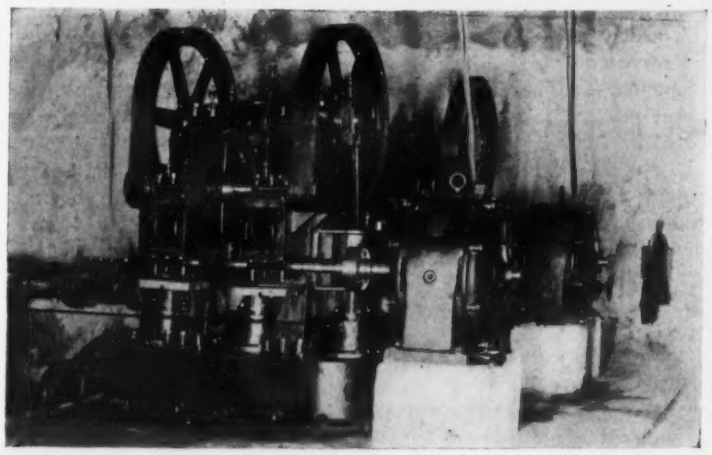


FIG. 5.—ELECTRIC PUMP, 500-FT. LEVEL, PREMIER MINE.

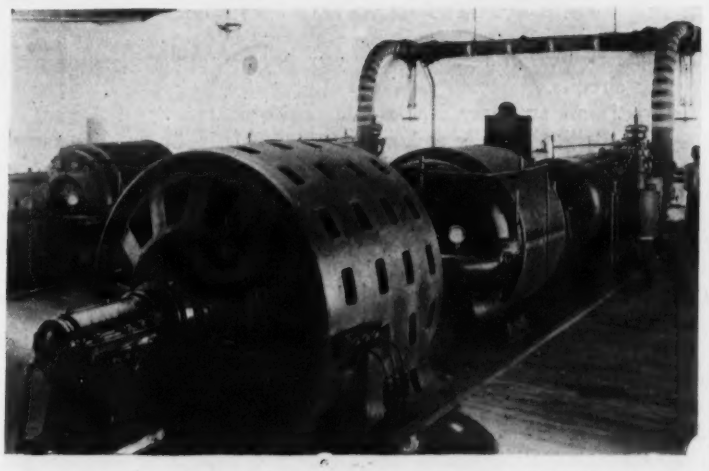


FIG. 6.—1000-KW TURBINE, CENTRAL POWER STATION.

The approximate dimensions and weights of a turbine, exclusive of generator, are as follows: Length, 34 ft.; width, 9 ft.; height above floor line, 7 ft.; total weight, 130,000 pounds; heaviest piece, 45,000 pounds.

The generators are of the rotating field type, the rotating part being built upon an extension of the turbine shaft. The armature has a three-phase winding for a normal output of 1,000 kw, viz.: 115 amp. per terminal at 5,000 volts with non-inductive load. The machines have four poles and are adapted for operation at 1,500 r.p.m., giving 50 cycles per second. The separately excited fields require 120 amp. at 80 volts when the armature delivers its full rated current at 115 amp. per terminal at the normal e.m.f. of 5,000 volts at 100 per cent. power factor. The machines require 15 per cent. greater current when the armature delivers its full rated current at normal voltage at 90 per cent. power factor.

A load of 115 amp. per terminal at 5,000 volts at unity power factor may be thrown off and the e.m.f. will rise approximately 8 per cent., with constant speed and constant separate excitation. The machines operate for 24 hours at 5,000 volts and 115 amp. per terminal under 85 to 100 per cent. power factor, with a rise in temperature in no part exceeding 40° C., and at 25 per cent. greater current with the same power factor for 24 hours the rise in temperature does exceed 55° C.

For exciting the fields there are installed two Westinghouse motor-generator exciter sets, each consisting of a 50-hp, 220-volt, alternating-current motor mounted on a common base with, and direct-connected by means of a flexible coupling to, a 37.5-kw, 110-volt, direct-current generator. These outfits run at a speed of 720 r.p.m. The current supplying these exciter sets comes from a bank of three 100-kw, oil-insulated, self-cooling Westinghouse transformers, the primary of these being 5,000 volts and the secondary 220 volts.

The switchboard, consisting of six high-tension feeder panels, three high-tension machine panels, one high-tension station panel and six low-tension local distribution panels, was all supplied by the General Electric Company, and takes care of the generators, exciter sets, transformers and all the outgoing 5,000-volt, three-phase feeder

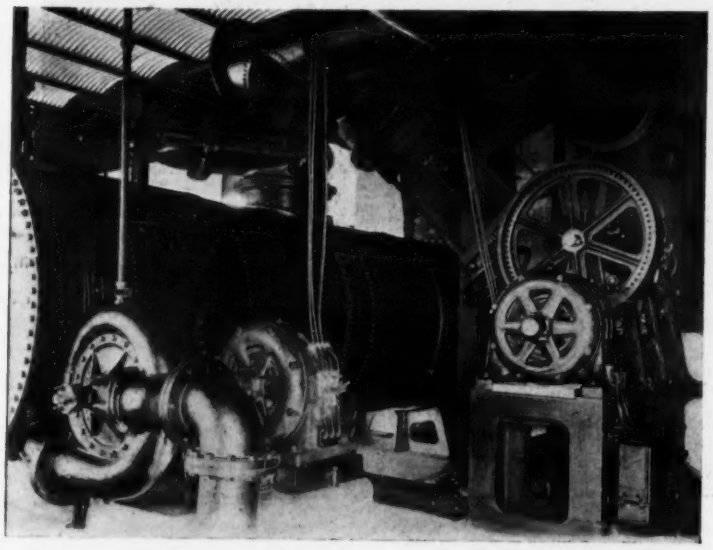


FIG. 7.—CONDENSERS, CENTRAL POWER STATION.

circuits, together with the local power house, auxiliary motor and lighting circuits.

There is an auxiliary Belliss-Westinghouse set, consisting of a 125-B.hp Belliss engine and one 75-kw Westinghouse alternator. The Belliss engine is capable of developing 125 B.hp when running at a speed of 600 r.p.m., and with steam at the engine valve at a pressure of 140 pounds per square inch and working non-condensing. It will develop 135 B.hp under and 130 to 150 pounds of steam when running condensing. The auxiliary set is a precautionary measure, as in case of the entire shutdown of the power station it will supply current to operate the exciter motors for the main generators.

The various motors used in the power station itself, such as those for driving coal conveyors, circulating pumps, air pumps, feed pumps, stokers, coal breakers, etc., are operated from a 220-volt, three-phase alternating-current circuit. Each set of pumps is driven by a 20-hp, three-phase induction motor running at 750 r.p.m., supplied by the General Electric Company. Westinghouse alternating-current motors drive Robins coal conveyors, Blake & Knowles pumps, Fraser & Chalmer compressors, etc. The coal-conveying plant is driven by a 10-hp General Electric alternating-current motor. The coal is passed through coal crushers operated by a 20-hp, alternating-current motor, also supplied by the General Electric Company.

There are at present installed eight Babcock & Wilcox boilers, each of 3,580 sq. ft. of heating surface, set in four batteries. The pressure is 150 pounds per sq. in. Eight superheaters having 339 sq. ft. of heating surface and capable of imparting about 75° F. of superheat, are installed. There are eight sets of chain grate stokers which have sufficient grate area to burn 1,200 pounds of coal per hour, with necessary hoppers and gearing. Draft is produced by fans of induced draft type. One is driven by a direct-connected, double-

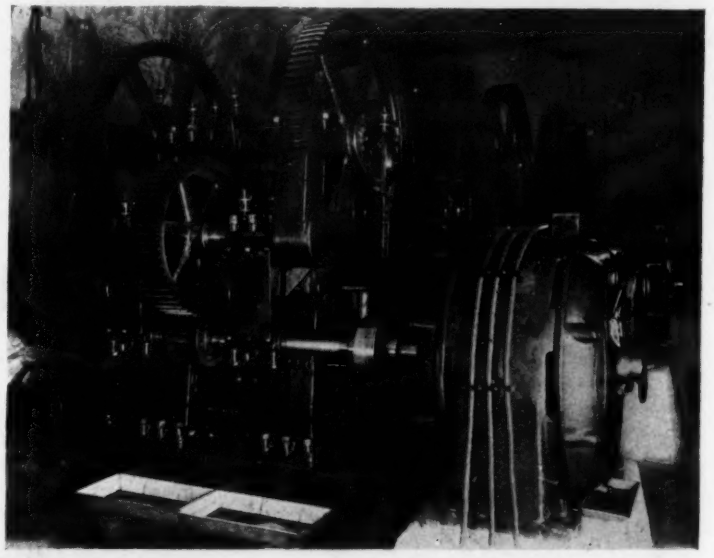


FIG. 8.—ELECTRIC PUMPS, 750-FT. LEVEL DUTOITSPAN MINES.

enclosed engine running at a speed of 275 r.p.m., and another of similar dimensions by a 50-hp, alternating-current, 220-volt motor. There are two Green economizers, each of 480 tubes in three sections with scrapers and gearing arranged to be driven electrically.

The condensers, which are capable of dealing with 40,000 pounds of exhaust steam per hour each, have 5,000 sq. ft. of cooling surface. There are two 8-in. Gwynne centrifugal pumps, together capable of delivering the water required to condense 40,000 pounds of steam per hour to a height of 40 ft. The speed of these pumps is 879 r.p.m., and they are driven by 32-hp, 220-volt, alternating-current motors.

Three-phase currents at 5,000 volts are transmitted to fifteen sub-stations by means of about 29 miles of high-tension cable, laid to all important points for service in duplicate. High-tension current is also transmitted from surface sub-stations down five different mine shafts to sub-stations located underground, ranging from 600 ft. to 2,200 ft. below the surface. Cables at these points are carried directly to transformers without the use of switches or cut-outs. This method was adopted as a precautionary measure to prevent accidents to natives due to coming into contact with dangerous high currents in any point underground. This cable is three-core, insulated with patent impregnated paper, lead-covered and armored over the lead with a double layer of steel tape laid on a bed of impregnated jute, and served over all with another layer of jute yarn, and thoroughly compounded. The high-tension cables used for shaft work are rubber-insulated, lead-sheathed and steel-wire armored, being supported in shafts by means of hardwood cleats.

Low-tension cable is used for transmitting power from the underground sub-stations to the different points necessary to operate motors driving pumps, haulages, hoists, creepers and for electric traction. Approximately three miles of this cable are in use. It is insulated in the same manner as the high-tension cable.

The Alexandersfontein Electric Railway has been constructed by the De Beers Company for the purpose of providing the employes of the company and the residents of Kimberly and Beaconsfield with a cheap means of getting out to the only pleasure grounds within easy access of Kimberly, situated at the Alexandersfontein Hotel, a magnificent place owned by the De Beers Company. The line equipped is approximately seven miles in length, without stops between termini, and is operated by current supplied from a sub-station.

The car equipments consist of 35-hp Westinghouse motors and Westinghouse controllers.

In the sub-station are two 300-kw Westinghouse rotary converters, 350-575 volts, together with a direct-connected starting motor; also six 110-kw, oil-insulated, self-cooling Westinghouse transformers.

The foregoing deals in a general way with the power station outfit and the use made of the current generated at present. An order has just been placed with the British Westinghouse Electric & Manufacturing Company, London, for another unit of 1,500 kw capacity. This has been found necessary owing to the increased demand for power in the works, and also for the operation of the Kimberly to Alexandersfontein Electric Railway. Arrangements have also been made with the Beaconsfield Town Council, which is a suburb of Kimberly, to supply current to the Beaconsfield Tramway. The Kimberly town lighting has just been taken over and is operating successfully.

Electric power is used throughout the works, in the work shops and in the mines. A large number of electrically-operated pumps, as above noted, are in service, as well as twelve Baldwin-Westinghouse electric locomotives. The supply being alternating current, the flexibility of this system is shown to best advantage, the various sub-stations in service arranging the voltage to meet all requirements for continuous and uninterrupted service.

For the information contained in the above article we are indebted to Mr. A. F. Williams, assistant general manager of the De Beers Consolidated Mines.

Why Steam Locomotives Must be Replaced by Electric Locomotives for the Heaviest Freight Service.

By H. Ward Leonard.

THE question as to whether our trunk line railways will in the future be operated by electric power depends upon the answer to the following question: Can the ton-mile be produced on existing railways at a lower cost by steam locomotives or by electric locomotives?

The average person, when his attention is directed to the possibility of electrifying trunk line railways, thinks of the possible increase in the speed of passenger trains.

The speed of passenger trains is never going to be a factor of determining importance in considering the advisability of operating existing railways by electric power.

Over 70 per cent. of the gross railway receipts of this country are derived from the freight traffic, and when we consider the net income of the railway the percentage of the total net income that is due to the freight service is probably at least 75 per cent.

Among those who appreciate fully that the cost per ton-mile contains the answer to practically all railway questions, the writer has, thus far, been the only one who has claimed that ultimately the decision as between steam and electricity will be in favor of that form of power which can deliver to a train, under reliable and efficient control, the greatest number of horse-power.

Those who have publicly discussed the question heretofore have analyzed carefully the relative cost of delivering an equal amount of power by steam locomotives and by electric locomotives, and have invariably concluded that in view of the capital charges involved and the central station costs and similar charges, the electric locomotive has little, if any, advantage over its steam rival; and hence that the steam locomotive is secure in the field of heavy freight transportation.

The writer takes issue with this conclusion and will endeavor to present herein facts and arguments tending to show that the electric locomotive will, because of great economic superiority, replace steam locomotives upon the railways having the heaviest freight traffic.

As a preliminary to the consideration of the main subject, the following instances, familiar to all, are cited to illustrate the fact that the cost per horse-power has not been the determining factor in other fields of transportation.

The ocean freighter with a high percentage of the total cost per ton-mile due to power, has replaced the sailing vessel where the cost of power per ton-mile was almost nil.

The modern electric car employing 200 hp and frequently more has grown in a few years from 15 hp to its present power not because of the reduction in the cost per horse-power, but because there was greater economy in the larger and higher-powered transportation unit.

The term "power" is so loosely used in steam railway practice that it seems desirable to emphasize at this point the fact that power is represented by the product of pull and speed. It is unfortunate that the term "tractive power" is in almost universal use to-day when tractive effort is meant.

In order to bring out clearly the difference between pull and power and the significance of this difference in railway economics, it may be well to state that the pull of a locomotive is greatest when it is moving slowly on a grade and taking steam full stroke; but its power is least under such conditions.

A modern compound freight locomotive, which produces about 1,400 hp at 18 miles per hour, with a pull at the drawbar of 30,000 pounds, can produce as a maximum about 50,000 pounds drawbar pull, but to do so will have to reduce its speed to, say, three miles per hour, and will then produce only about 400 hp.

This can be stated another way by saying that if we have a certain boiler, capable of producing steam at a certain rate and pressure, the greatest power can be obtained from the steam by using it expansively, first in the high-pressure cylinder and then in the low-pressure. As the steam locomotive has no change gear device by which the pull can be multiplied at the expense of the speed, steam must be taken full stroke to secure maximum pull. But taking steam full stroke means developing steam power in the most inefficient way—a way practically unheard of to-day outside of the steam locomotive.

It is a most unfortunate fact for the steam locomotive that just when the heaviest grade is encountered and the demand exists for from three to six times the power required on the level in order to maintain sufficient speed to prevent traffic congestions, the power of the steam locomotive, instead of increasing in response to this temporary demand for increased power, actually falls to about one-third or one-half of its maximum power.

The boiler is the limiting feature of the steam locomotive. There is a limit to the steam pressure which can be efficiently employed. There is a limit to the amount of coal which can be burned on the limited grate surface in the limited firebox. There is a limit to the work which the fireman, or even two firemen, can perform in stoking. All of these limits have been reached, or practically so, in the modern high-powered steam locomotive, and whatever this limit may be in favorable weather, it is again greatly reduced by conditions of extremely cold weather, when the reduced steaming capacity of the boiler, the reduced physical strength of the fireman and the bad track surface, all unfavorably affect the production of the increased horse-power needed to maintain schedule speed.

The modern four-cylinder compound locomotive is a direct confirmation of the demand for higher powered locomotives. The additional first cost, complication, depreciation and unreliability of the compound type are only warranted by the fact that a greater horse-power can be produced from the limited amount of steam which the boiler can generate, when the steam is used "compound," and that hence more ton-miles can be produced per train per day if compound locomotives be employed.

The rapid growth in favor of the four-cylinder compound locomotive is best shown by the following table. The heating surface is the best available means of forming an approximate idea of the power:

	Total heating surface of all locomotives in use in United States.		Increase of power in 1903 over 1902.
	In 1902.	In 1903.	Per cent.
Single-expansion locomotives	53,100,000	64,300,000	21
4-cylinder comp. locomotives	3,000,000	5,300,000	76

It will be observed that the power represented by the compound type increased, in 1903, 76 per cent. over the corresponding figure in 1902, while the power increase in single-expansion type was only 21 per cent. over that of 1902.

The boiler capacity of the locomotives recently put into service is extremely high as compared with the average in service. In 1902 the average United States locomotive had 1,560 sq. ft. of heating surface. The average heating surface of the locomotives added during the last year reported was 2,300 sq. ft.—an increase of 50 per cent. in the horse-power capacity of the boiler and a still greater percentage increase in the effective horse-power relative to the average, because so many of the new locomotives were compounds.

It is unfortunately true that horse-power is an almost unused term in railway statistics.

Every matter which is considered of importance for comparison is reported by many railways, and the annual report of railways statistics by the Interstate Commerce Commission, *Poor's Manual*,

Financial Chronicle and other publications, give data on almost everything conceivable as to railways, except power. The word "power" does not occur in an index of these publications and when this word is used it is generally improperly used to mean tractive effort.

The lack of data as to the power required for moving trains under various conditions is well illustrated by the fact that when the New York Central Railway, in the recent past, was forced by legislation to consider the substitution of electric locomotives for steam locomotives in the tunnel at its New York terminal, no reliable data was available by which the aggregate horse-power needed could be estimated with even approximate accuracy, and a long series of tests were, therefore, conducted to obtain such power data regarding their regular trains.

Judging by this data and such other scattering data as has been obtainable, it is estimated by the author that the maximum horse-power of the average United States locomotive is about 600 hp.

Assuming this figure, we obtain a total power for all locomotives in the United States, upon June 30, 1903, of 26,300,000 hp, of which about 18,706,000 hp is employed in the freight service.

The increase in ton-mile production resultant from the use of the higher power obtainable by the use of the compound type of locomotive seems likely to result in a rapid replacement of the single-expansion type by the compound type. We have already seen that the rate of growth of the compound is very rapid. Yet, so recent is this development that upon June 30, 1903, less than seven locomotives out of 100 in use in the United States were of the compound type.

It may fairly be said that nine freight locomotives out of ten in use to-day are of an obsolete size or type, and it is probably true that higher economy would be obtained by scrapping these locomotives of obsolete type and purchasing the modern compound type, than by nursing along these old type locomotives and thus postponing the economies in the cost per ton-mile due to increased train loads moving at higher speeds; that is, due to greater power in the locomotive.

The cost of a modern compound freight locomotive of the largest size is about $22,000. The charge for maintenance is about $3,500 per annum; that is, roughly, 15 per cent. per annum on its cost. The maintenance of electric locomotives, judging by the experience met with thus far, will not exceed 5 per cent. per annum. The last reports of many of the leading railways show that a modern freight locomotive costs as much per mile run, for maintenance, as it does for fuel.

There is great significance in the statement of the president of the Union Pacific Railway in the recent 1904 report as follows: "The locomotives added during the year averaged 99.57 tons total weight of engine without tender, and 73 tons upon the drivers." The average weight on drivers of all the Union Pacific locomotives then in use was 57.8 tons.

The average weight on drivers for all United States locomotives in 1903 was 47.5 tons.

It is evident from these figures that the power per train in the case of the Union Pacific is already high and rapidly growing higher.

This is confirmed by the fact that the average train load in 1904 was 451 tons, against 278 tons in 1898.

The Union Pacific Railway was operated last year for 51.5 per cent. of its gross receipts. Its improvement in recent years in operating economies make it conspicuous and its showing certainly appears to confirm the writer's contention that increase in train power means increase in operating economy.

The recent Atchison report shows that although that progressive road had, upon June 30, 1903, the very high average tractive power per locomotive of 22,526 pounds, it had succeeded in raising this figure to 25,578 upon June 30, 1904, an increase of 13.55 per cent. in one year.

The president of the Pennsylvania Railroad Company, in his last report, said: "The conditions most favorable to an economical movement of traffic existed in 1899, when, although the volume of business upon the line between New York and Pittsburg was larger than in any preceding year, and 19 per cent. in excess of that of 1898, the facilities, though not overtaxed, were yet fully employed. As a result the records show that the cost per ton-mile was the lowest in the experience of the company, having been less than 3½ mills. * * * * * In 1903 there is an increase of 31 per cent. over the tonnage of 1899. * * * * * The congested condition of your system has brought about a large increase in the ton-mile cost, which for 1903 was 25 per cent. greater than that for 1899."

It seems apparent from what we have heretofore seen that increase in the power applied to the train has resulted in economy and that lack of economy has resulted from a lack of the power needed to move congested freight at a sufficiently high speed.

In order to place clearly before the reader some of the most important elements entering into the problem, the writer has prepared a tabulated statement showing the ultimate distribution of the total transportation receipts of all United States railways, the cost of power being separated and shown with as great a degree of accuracy as the statistics at his command will permit of.

From this statement we learn that 20 per cent. of the gross transportation receipts is approximately the cost of the power employed upon United States railways.

An examination of these figures as to the cost of power leads to the conclusion that it is probably fair to say that only about three-quarters of it, or say 15 per cent. of the gross transportation receipts, will be increased as the power per train is increased, up to the limit commercially possible.

In other words, if we can add to our train load and simultaneously increase our power sufficiently to maintain the same schedule speed as before, 15 per cent. of the added gross receipts due to the added load will pay for the increased ton-mile production and 85 per cent. of the added gross receipts becomes an increase in gross profit.

The figures given clearly illustrate why the maximum train load moved at an economical steam expansion and hence at nearly the highest rate of speed, results in the lowest cost per ton-mile; and why an increase in freight so great as to result in slow-moving trains, and causing a reduction of horse-power due to lack of proper steam expansion and also causing increased coal consumption due to inefficient power production, results inevitably in a great increase in the cost per ton-mile.

Attention is directed to the cost of fuel which is only 7.7 per cent.

DISTRIBUTION OF TOTAL TRANSPORTATION RECEIPTS. ALL UNITED STATES RAILWAYS, FOR THE YEAR ENDING JUNE 30TH, 1903.

Power.	Amount.	Per cent.
Fuel for locomotives	146,500,000	7.7
Engine and roundhouse men	120,000,000	6.3
Repairs and renewals of locomotives	93,000,000	4.9
Repairs and renewals of shop machinery and tools	8,700,000	.5
Water supply for locomotives	7,700,000	.4
Oil, tallow, waste and other locomotive supplies	7,800,000	.4
Total cost of power	383,700,000	20.2
Conducting transportation (exclusive of power)	419,600,000	22
Maintenance of way and structures	256,900,000	14
Maintenance of equipment (exclusive of locomotives)	138,500,000	7.3
Salaries, office expense, legal, insurance, etc.	47,600,000	2.5
Interest on funded debt, taxes, etc.	287,700,000	15.3
Net dividends	166,000,000	8.7
Available for improvements and adjustments	191,000,000	10
Total transportation receipts U. S. railways for the year ending June 30, 1903	$1,900,000,000	100

of the gross receipts. This cost of fuel has been the principal topic discussed in former articles on this subject. The insignificance of saving a part of the fuel cost, which is only 7.7 per cent. of the gross receipts, as compared with the ability to produce greatly increased power, which directly increases the gross receipts per train mile, will be apparent.

Perhaps the most convincing figures as to the demand for increased horse-power per locomotive are to be found in figures as to the heating surface of the locomotives recently designed for the most progressive railways.

The average United States locomotive had, upon June 30, 1903, only 1,660 sq. ft. of heating surface. The power may be roughly estimated at 600 hp per locomotive.

The highest powered locomotive produced up to 1898 had 3,300 sq. ft. of heating surface and being compound the horse-power can be roughly estimated at 1,500.

In 1903 the Baldwin Locomotive Works supplied to the Atchison, Topeka & Santa Fé Railway 70 compound locomotives, each having a heating surface of 4,800 sq. ft. and capable of producing about 2,000 hp, and numerous other railways purchased compound locomotives of equal horse-power. One of these locomotives can haul a 2,000-ton train at 18 miles per hour on a grade of ½ per cent. (26 ft. to 1 mile), and two such locomotives can haul at about 6 miles per hour a 2,000-ton train on a 2½ per cent. grade.

In 1904 a locomotive was exhibited at the St. Louis World's Fair having 5,600 sq. ft. of heating surface and probably capable of producing approximately 2,500 hp. This locomotive can prob-

ably haul 2,500 tons up a 2½ per cent. grade at 6 miles per hour.

This 2,500-hp steam locomotive is significant, as it is practically two locomotives having a common source of energy; that is, the one boiler, and a single control for the two locomotive units, each of which has six driving wheels for the rigid wheel base, the forward engine with its two cylinders, six drivers and steam pipes being articulated relative to the frame, boiler and rear engine, which is rigidly connected together.

Here is the admission by the steam locomotive designer that what he wants is several distinct locomotives supplied from a common source of energy and subject to a common control by one operator. The designer has dared to go to 2,500 hp, but he cannot go much further, because his drawbar pull is all applied through one drawbar at the head of the train, and the 80,000 pounds drawbar pull which

The place where the demand for enormously greater power upon freight trains is most keenly felt is in the mountain section which nearly every railway has.

It is a fortunate thing for the electric locomotive that natural power usually exists in such mountain sections. An abundant source of water power is usually available, which will greatly assist in the early application of electric locomotives upon the mountain sections of progressive railways which are at present struggling with the overtrained steam locomotive which is entirely out of place upon these mountain sections.

If it be granted that the trunk line railways are embarrassed by a lack of sufficient power to move an unbroken train at a satisfactory speed up the mountain grade, and that great economies in freight movement would result in having the desired power in efficient form,

FREIGHT TRAFFIC DATA.

	All United States railways, 1903 report.	Group II, Middle States Railways: N.Y., N.J., Pa., Md., Del., 1903 report.	Penn. R.R. 1903 report.	N.Y. Central, 1904 report.	Atchison, 1904 report.	Union Pac., 1904 report.	Pittsburg & Lake Erie.
Ton miles (revenue freight)	173,221,000,000	47,127,000,000	14,846,000,000	6,939,000,000	4,682,000,000	4,053,000,000	1,456,000,000
Freight revenue	$1,338,000,000	$318,816,000	$89,896,000	$46,234,000	$47,762,000	$39,452,000	$10,000,000
Freight revenue per ton-mile	.763 cent	.667 cent	.6 cent	.66 cent	1.02 cent	.97 cent	.69 cent
Number of freight locomotives	25,444	.....	1,643	927	.....	.....	.....
Miles of line	207,977	22,466	3,656	3,490	8,180	5,353	191
Ton-miles per mile of line	855,442	2,071,000	4,061,000	1,997,690	572,400	757,000	7,600,000
Freight revenue per mile of line	$6,629	$14,010	$24,591	$13,311	$5,840	$7,370	$52,300
Ton-miles per freight locomotive	6,808,000	.....	9,036,000	7,485,000	.....	.....	.....
Revenue per freight locomotive	$52,600	.....	$54,700	$49,880	.....	.....	.....
Average revenue tons per train	310.5	406.	527	359	270	451	.....
Ton-miles per mile of line per freight loco.	33.6	.....	2,470	2,155	.....	.....	.....
Rev. miles run per annum per freight loco.	21,557	.....	17,140	20,540	.....	.....	.....
Revenue per freight loco. per mile	$2.44	$2.74	$3.19	$2.39	$2.75	$3.68	$6.54
No. of miles of line per freight loco.	8.17	.....	2.22	3.76	.....	.....	.....
Av. tractive effort per freight loco.: lbs.	.....	.....	30,000	.....	.....	.....	.....
Av. heating surface per loco.: sq. ft.	1660.	.....	.....	.....	.....	.....	.....
Av. hp (approx.) per freight locomotive	600	.....	.....	.....	.....	.....	.....

this locomotive can produce seems likely to be as much as existing equipments can stand.

A desirable arrangement for hauling existing cars would be one in which there would be a train requiring about 40,000 pounds drawbar pull, with a locomotive capable of delivering this drawbar pull at, say, 20 miles per hour. Then back of this train another similar locomotive and another similar train, all coupled together, and then still another such locomotive and another such train. These three locomotives should be under simple, efficient, and reliable control at any speed and in either direction, and from either end of the long train, by a single operator.

The three locomotives giving 120,000 pounds drawbar pull, at 20 miles per hour, would deliver 6,400 hp at the drawbars and would haul a 2,000-ton train up a 2½ per cent. grade at 20 miles per hour. Similarly they would haul a 4,000-ton train up a 1 per cent. grade at 20 miles per hour, or a train of 6,000 tons up a grade of ½ per cent. at 20 miles per hour.

The writer has devised a simple method of calculating such powers with reasonable accuracy as follows: Multiply the drawbar pull in pounds by the speed in miles per hour, and then double this product. The result is the number of watts. Dividing by 1,000 we get the kilowatts and to get the horse-power add one-third to the number of kilowatts.

There are methods available to-day by which any desired number of locomotive units can be distributed through a train and controlled by a single operator from any desired location along the train. It is true that thus far such methods have not been applied to several units of 2,000 hp each distributed in a freight train, but this is solely due to the fact that it is not believed by railway managers that economy would result therefrom, for the necessary locomotives and methods of generation, transmission, application and control, can be to-day purchased upon satisfactory guarantees from responsible parties in Switzerland.

Thus far, multiple power units for train propulsion have been applied solely because of their advantages as to rapid acceleration of passenger trains on elevated railways and in subways, and the fact has not been appreciated that multiple locomotive units properly controlled will enable us to operate at any desired speed, a freight train of any desired weight, the only limit thus far apparent being that imposed by the block section length and possibly the existing car brakes.

and under reliable and simple control, it needs no prophet to predict that electric locomotives offer the only method of delivering to the train the power required.

If there be any railway which is satisfied with the speed and train load which it now obtains on its heaviest mountain grades such a railway must be unaware of the causes which have forced the design of the 2,000-hp and 2,500-hp mountain climbers, which are not inappropriately dubbed "monsters."

As an example of power generation, and the application of such power to a modern freight train moving on the various grades up to 2½ per cent., it would be difficult to conceive of anything worse adapted to the duty than a steam locomotive. It is a marvel of mechanism, forced to work under the worst possible conditions.

By the time that one-hundredth part of the skill thus far expended in designing the steam locomotive has been spent upon the electric locomotive, the steam locomotive will have taken its place beside the horse car in the survival of the fittest competition.

Steam generation of power is certain to survive for many applications, but heavy power transmission at widely varying pulls by pistons, cranks and parallel rods, upon a rigid moving wheel base, cannot survive against the flexible electric transmission of power at variable speed and torque and under perfect control.

In order to compare certain other statistics of importance, the author has prepared a table giving certain data as to all United States railways considered as a system, the railways of group II (Middle States) as classified by the Interstate Commerce Commission reports, the Pennsylvania, the New York Central, the Atchison and the Union Pacific.

Rating the average United States locomotive at 600 hp maximum, we find that the rated maximum horse-power per mile of line averages 125 hp.

There is a very general but mistaken impression that the first cost of electric locomotives will be much more than that of steam locomotives.

The only way to compare them properly is by the ton-miles per annum they will produce.

An electric locomotive which will produce an equal ton-miles per annum will have a first cost which is less than the first cost of the equivalent steam locomotive.

The cost of a modern steam freight locomotive per pound on drivers is about 9 cents per pound. A modern steam locomotive has

about 117 pounds on drivers per horse-power, based on its maximum horse-power.

There is no difficulty in designing an electric locomotive for the heaviest freight service and using the best known system of generation transmission and control, so that it will have 125 pounds on drivers per horse-power at the drawbar when maintaining the desired speed.

Such a locomotive when commercially manufactured can be readily sold for 8 cents per pound, or $10 per hp at drawbar.

That is, a 2,000-hp electric locomotive can be sold for $20,000. Such a locomotive can be worked on mountain grades of a few miles in length at 3,000 hp with perfect results.

The 2,000-hp steam locomotive costs $22,000, or $11 per hp, and has no overload capacity beyond the figure named, which is its maximum horse-power under the most advantageous conditions.

The most favorable case for electric freight service will be the electrification of the mountain sections of the principal railways or the entire line of a railway having an already very dense freight traffic, and where such traffic is rapidly growing, and where, therefore, greatly increased train power will produce greatly increased profits.

The combined tractive efforts of the Pennsylvania Railroad freight locomotives increased from 40,800,000 pounds in 1902, to 50,200,000 pounds in 1903.

This 25 per cent. increase in tractive effort in one year with an equivalent increase in power clearly indicates the urgent demand for more power on that railway.

Just as in the former street car practice a light car was essential when the power was limited to horses, and the horses laboriously moved the car on a 6 per cent. grade at a slow speed, so the modern steam locomotive, with its limited power, moves the relatively light freight train at a slow speed on the mountain grade, and just as the gigantic trolley car of to-day rushes at nearly full speed up a grade of 6 per cent. driven by a source of practically unlimited power and responding without injury to the demanded production for a short time of some six times the power needed on the level, so will the future electrically-driven freight train rush up the present mountain grades at a speed which will make the speed of to-day on mountain grades seem ridiculous.

If one per cent. of the money spent per annum in the reduction of grades and the straightening of curves were spent in building electric locomotives and power plants to use them, where increased power is needed, most of the vast sums being blasted and shoveled away would be saved and a far better economical result would be obtained than can ever be hoped for by the use of steam locomotives.

Let us now look briefly at the effect which would follow a possible reduction in the cost per ton-mile. Most people, no doubt, think that the cost of the ton-mile is a matter of little concern to them.

The railways of the United States were paid by the inhabitants of the United States in 1903 for producing 173,221,000,000 ton-miles; that is, every man, woman and child in the United States paid to the railways, as an average, last year, the price of 2,160 ton-miles; 8 tons were moved over 250 miles for every inhabitant of the country. In 1893 the per capita production was only 1,430 ton-miles. In 1880 it was 645 ton-miles per capita.

The inhabitants of the United States paid to the railways last year for freight transportation at least $1,320,000,000.

It will be evident from these figures that the price paid to the railways per ton-mile vitally affects the per capita income and wealth of this nation and a material reduction in the ton-mile selling price is an important source of wealth.

To illustrate this the reader need only be reminded that the enormous wealth of the Standard Oil Company was built up out of a small percentage rebate on the ton-mile price.

On account of competition the railways have thus far promptly given to the public most of the benefit due to savings effected in producing the ton-mile. In 1903 the average selling price of the ton-mile was .76 cent. In 1893 it was .88 cent. In 1890 it was .94 cent. The ton-mile price has, therefore, been reduced 20 per cent. since 1890.

If the freight moved last year had been paid for at the rate which prevailed in 1890, the public would have paid to the railways last year $312,000,000 more than it actually did pay.

This enormous annual saving is equivalent to dividing among the inhabitants of this country a dividend of 2½ per cent. upon the $12,600,000,000 of railway stocks and bonds outstanding in this country. It is practically equivalent to dividing among the inhabitants of the United States all the gold annually produced in the world.

It seems safe to say that the most important factor in the recent enormous production of wealth in America has been the startling reduction in the price of the ton-mile.

Enough has been said to make it clear that there is no subject in which the general public is more interested than in the cost of production of the ton-mile. It is hoped that sufficient evidence has been presented to make it clear that economies in the production of the ton-mile are radically influenced by the amount of power than can be commercially applied to a freight train.

It seems apparent that the power which can be applied by steam locomotives to a train is rapidly nearing a limit and leaves much to be desired. It also seems apparent that there is no reasonable limit to the power which can be applied to a freight train by a multiple of electric locomotives under simultaneous control by one operator.

In view of the existing conditions and possibilities indicated by the statistics and the known performances of electric locomotives, especially of the type designed and tested for hauling standard freight trains up 2½ per cent. grades in Switzerland, it seems to the writer reasonable to expect that the present record of .35 cent per ton-mile can be reduced by electric locomotives to .25 cent per ton-mile, merely by increasing the existing train loads and applying to the train sufficient electric power to drive it at the maximum economical speed.

The electrification of trunk lines is a problem for the trunk lines themselves to analyze, investigate and to experiment upon. The trunk line railways themselves have infinitely more to gain from electrically equipping their lines than have the electrical manufacturers.

When the first trunk line railway becomes worldwise electrically trunk line electric traction will follow in a few years. Of all countries in the world, this is the only one having railways whose freight, roadbed, cars, grades and management would enable them to promptly secure the enormous economic advantages which would result from the application of greatly increased power to freight trains by means of electric locomotives.

Which railway will win the undying distinction of having been the first to reduce the cost per ton-mile by means of trunk line electric traction? It is to be hoped that this distinction will not go to a foreign railway, as now seems likely.

Telephoning a Wedding.

The following item appears in Washington dispatches to a New York daily newspaper, a few days ago: "Sitting cozily in her flat in Washington this afternoon, Mrs. H. L. Van Matre attended the Baltimore wedding of her daughter. Mrs. Van Matre was confined to her room by illness and could not go to Baltimore. The wedding was an elaborate affair with numerous bridesmaids and ushers, and Mrs. Van Matre sat with a telephone receiver at her ear and heard the whole ceremony, including music and prayer. One of the maids of honor also telephoned a graphic description of the scene. By arrangement the ceremony took place near a telephone, and every word was spoken by the clergyman, the bridegroom and the bride as distinctly as possible, so that the invalid mother might hear."

Bangor Municipal Plant.

The City Council of Bangor, Me., has created a committee to consider the question of taking action and securing such action by the State Legislature as may be necessary to empower the city to generate and sell electric light, power and heat to the residents of Bangor and vicinity. The city has at the water works dam an electric plant of its own, where is generated the current for all municipal lighting, and as a great amount of power is running to waste over the dam the question has been raised whether it would not be a good thing for the city and its people to utilize this waste power in the manufacture of electricity. The City Council has also voted to double the capacity of the municipal lighting plant.

Naval Wireless System.

Rear Admiral Manney, chief of the Bureau of Equipment of the Navy, has just completed plans for the system of wireless telegraphy all along the Atlantic Coast. Some of the stations will be 250 miles apart.

The Electrical Testing Laboratories.—I.

By Clayton H. Sharp.

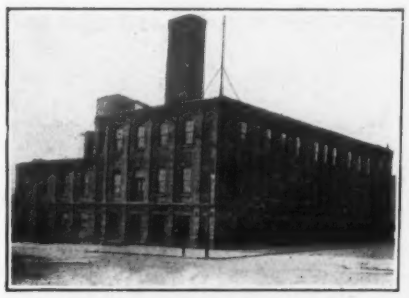


FIG. I.—ELECTRICAL TESTING LABORATORIES.

IN spite of the fact that the indutsrial applications of electricity in this country exceed in extent those of any other land, the facilities at the disposal of American engineers and manufacturers for obtaining reliable electrical tests have been much more meagre than are obtainable abroad.

In England the laboratories of the Board of Trade, of the Electrical Standardizing, Testing and Training Institutions, and, latterly, of the National Physical Laboratory have been available. In France the Laboratoire Central de l'Electricité has been organized for about fifteen years, and has been doing splendid service for electrotechnics. In Germany the Reichsanstalt has been fulfilling its splendid mission for about the same period of time.

In this country, while the largest manufacturing and purchasing concerns have, in recognition of the need of systematic testing, equipped private laboratories for that purpose, the body of electrical engineers and of smaller manufacturers and purchasers have been obliged either to forego all but the most simple testing or to have recourse to the unsatisfactory expedient of begging for such tests as they must have of unwilling and overbusy professors of technical schools and universities. It was in recognition of the need of commercial tests by a large part of the electrotechnical public and of this lack of facilities for obtaining them that the company called Electrical Testing Laboratories was incorporated.

The company is engaged in making electrical tests, standardizations and experiments of nearly any nature, its purpose having been so to equip its plant and to organize its operations that such work can be carried out on a strictly commercial basis, thereby placing at the disposal of consulting engineers, manufacturers, purchasers and the electrical public generally a laboratory in which any tests or experiments will be made for them at rates determined only by the cost of doing the work. It is the purpose of this article to describe the equipment prepared with this end in view.

The plant of the company is situated in the building (Fig. 1) on the corner of Eightieth Street and East End Avenue, New York. The location is a remarkably favorable one, since it is well removed from the disturbing influences of electric cars, heavy trucking and neighboring heavy machinery.

The building was formerly used as a generating station by the Manhattan Electric Lighting Company; is of fireproof construction, and on account of its size and of the great strength and rigidity of its walls and floors, is admirably adapted to laboratory purposes.

The main building is 50 by 120 feet, three stories high. The lowest floor, slightly below the level of the street, is concreted and is used as a machinery room. The next floor is devoted principally to the purposes of photometry. The top floor is occupied by offices and contains the laboratory for general electrical testing.

Back of the main building is a two-story addition, 30 by 120 feet, the lower floor of which is used for batteries and for general purposes and the upper floor for housing the life-test racks for incandescent lamps. A further space, 20 by 120 feet, is also available, being used for storage purposes.

It will be seen that the building is amply large for all the requirements of an extensive testing laboratory.

A general view of the machinery room is given in Fig. 2. The concrete floor of this room has been laid level with the old engine foundations, which have been utilized as foundations for the electrical machinery which this room contains. Details concerning this electrical machinery will be given under the next heading.

FIG. 2.—GENERAL VIEW OF MACHINERY ROOM.

The non-electrical equipment of this room includes a sulphur dioxide refrigerating machine, having a capacity of a ton and a half of ice per day, together with a brine storage tank and a triplex pump for circulating the cold brine through pipes reaching to the top of the building. Besides this, there is a motor-driven air pump, which compresses air in a reservoir from which pipes lead to outlets in many parts of the laboratory. This compressed air

is used for operating blast-lamps, and is especially useful in removing the dust from articles, particularly delicate electrical apparatus.

For executing repair and construction work on apparatus a small but excellent equipment of light machine tools has been provided and installed on this floor.

Supply of Current.

All electrical energy used is purchased of the New York Edison Company, either in the form of direct current, 120-240-volt or of alternating current, 25 cycles, 6,600-volt, three-phase. The latter supply is by direct cable from the Waterside Station. The direct-current service is used for lighting, for elevator service, for motors generally, and for charging storage batteries. The alternating-current service drives a 150-kw motor-generator set supplying current for the life-test of incandescent lamps.

The storage battery equipment is as follows, all by the Electric Storage Battery Company: 70 cells "F-13," 60 amperes, normal rate, for power purposes; 285 cells "Exide" battery, 15 amperes, used for photometry; 400 cells "B. T." three-quarter ampere, used for voltmeter testing, supply of shunt windings of direct-current meters and pressure purposes generally; and, finally, 4 cells "G. 27," 260 amperes, which furnish heavy currents at low voltage for ammeter and wattmeter testing. The 300 "Exide" cells are divided into 3 batteries of 70 cells each and 5 batteries of 15 cells each. The 70-cell unit was adopted because this is the best number for the photometry of incandescent lamps of the 100-volt range. For higher voltages these batteries are connected in series, and for lower voltages combinations of the 15-cell batteries are used. The 400 "B. T." cells are divided into five batteries of 80 cells each, which can be connected in series, giving 800 volts. The "F-13" battery is charged and discharged at 120 volts through a booster set, the latter consisting in a 120-volt motor directly connected to a 50-volt, 100-ampere generator with field excited from the 120-volt circuit. The heavy current cells are charged from a motor-generator set giving 250 amperes at from 2 to 12 volts.

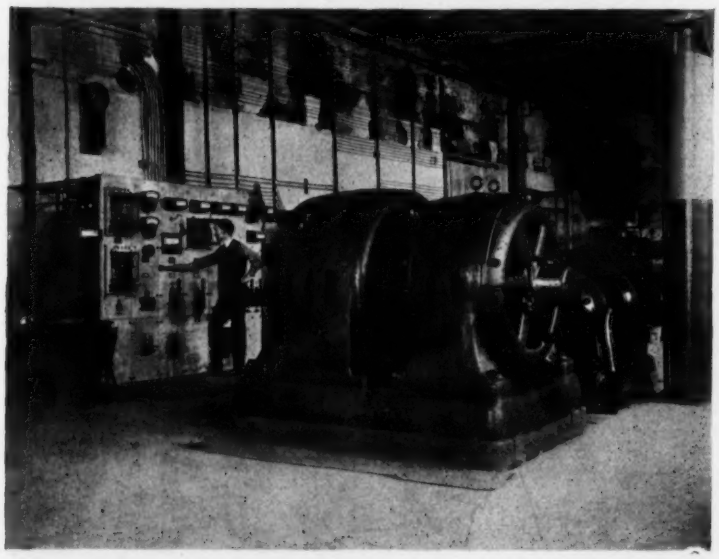


FIG. 3.—MOTOR-GENERATOR SET AND SWITCHBOARD FOR LIFE TEST.

The switchboard for battery control is seen near the centre of the general view of the machinery room in Fig. 2.

For life-testing incandescent lamps the source of supply is a 150-kw, 60-cycle alternator, directly connected to a 25-cycle, 6,600-volt, three-phase induction motor. (Fig. 3.) The field current for the alternator is furnished by a generator directly connected to a 25-cycle, 220-volt, three-phase motor. The life-test alternator feeds at 117 volts into an auto-converter, from which leads are brought out giving all the integral voltages from 100 volts to 140 volts. The close regulation of pressure, which is essential in life-testing operations, is secured by using the Tirrell-Andrews regulator. Two of these regulators are installed to insure against shutdowns due to failure of either to operate properly. A record of the day's operation is obtained by a G. E. curve writing voltmeter, the length of a 24-hour sheet being 12 feet.

For general experimental work with alternating currents and particularly for wattmeter testing, the set of machines shown in Fig. 4 is of great utility. In the background are seen the two direct-current motors of 15 horse-power each. These can be driven either from the Edison system or the storage battery. In the foreground is a pair of revolving field alternators mounted on a common bedplate, and so arranged that they can be rigidly coupled together. The armature rings of these machines can be given an angular displacement by means of handwheels and worm-gear. In testing wattmeters one of these machines furnishes current to the series coils and the other machine to the shunt coil of the watt-

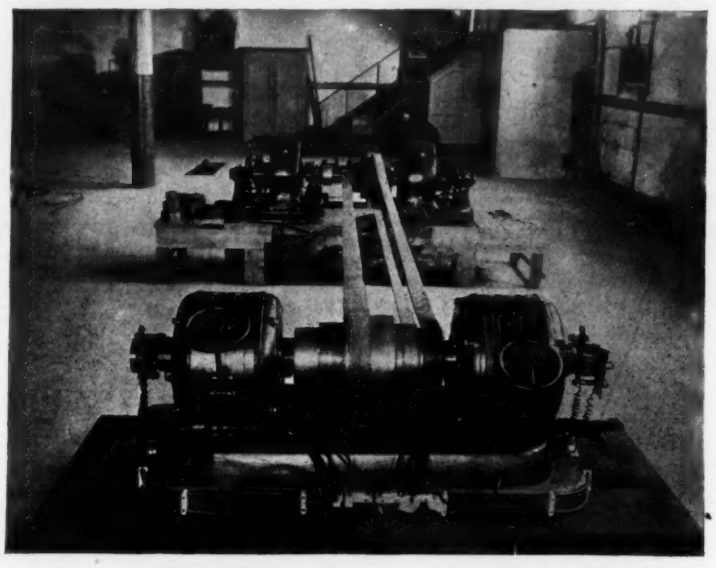


FIG. 4.—ALTERNATOR SET WITH POWER FACTOR ADJUSTMENT.

meter. By turning one of the hand wheels the angle between these currents can be varied at will, so that the wattmeter is tested at a power-factor corresponding thereto. A scale on the machines enables them to be set at any desired power factor.

Taps are brought out from the armature for twelve-phase current. By means of a plugboard attached to the frame, six-phase, three-phase, delta and Y, and also quarter-phase currents can be obtained. The wave-form varies somewhat with the connections used, being in some very nearly a pure sine, and in others having a moderately strong third harmonic. The means thereby furnished of obtaining a variety of wave-forms adds materially to the usefulness of the set.

These alternators are belt-driven by one or both of their motors. The belts run on three-step pulleys, so that any frequency of the alternating current can be obtained by using the proper step and by varying the speed of the motor. One motor is equipped to furnish frequencies from about 20 to 70, the other from 50 to 140. Thus the entire range of commercial frequencies can be covered and any frequency between the extreme limits of commercial practice can be obtained.

From what has been said it is evident that the range of currents which are at the disposal of the laboratories is very great, particularly since the cables of the Edison system leading to the building are of such size that 500 amperes at 240 volts are available from this source alone. The equipment for furnishing heavy currents at low voltage for ammeter and wattmeter testing, will be described in a subsequent paragraph.

Electrical Laboratory.

In the arrangement and equipment of the laboratories, the purpose for which they are intended was kept strictly in view. The work for which they are designed primarily is commercial testing, not research in pure science. The requirements of commercial testing demand that such work shall be carried out with promptness, at low cost and with a degree of accuracy sufficient to meet the needs of each special case. Having in view the minimizing of the labor cost of testing, the plan has been followed of laying out all the frequently recurring tests in advance. All requisite apparatus for such tests is put permanently in position and all electrical connections made, so that it is necessary only to connect the material or instrument to be tested into the circuit, close a switch or two and proceed to make measurements. In cases where tests are required less frequently, so that it is not found possible to set apart all the necessary apparatus for their exclusive use, a place has been assigned to

the tests and the electrical connections have been made so that but little preliminary work remains to be done.

The tables on which apparatus is thus permanently set up are constructed of 2-inch iron gas-pipe legs, flanged and screwed both to the floor and to a wooden framework on which the table top rests. The table tops are of stone. All tables have been carefully leveled in setting them up, so that an instrument placed on one of them is known to be in very nearly level position. Especial attention has been given to the insulation of the permanent wiring on the tables. Where very high insulation is necessary, not only have the wires been supported by porcelain knobs or cleats, but wire with extra heavy rubber covering (Navy standard) has been employed. The switches employed on the tables are of the back-connected type, and are mounted directly on the stone of the table top. This arrangement does away with the inconvenience of having wires stretched across the top of the table and puts the wires where they will be not only out of the way but also not liable to displacement. In order that connections between instruments may be made conveniently and circuits brought to the tables, the circuits are connected to rubber-covered binding posts, which are also of the back-connected variety and mounted on the table tops.

Galvanometers are for the most part mounted on the firm walls of the building. The lamp and scale method of reading galvanometers is, on account of its greater convenience, much more extensively employed than the telescope and scale method. Nearly all galvanometers are of the d'Arsonval type.

The circuits from the various sources of current, and from the

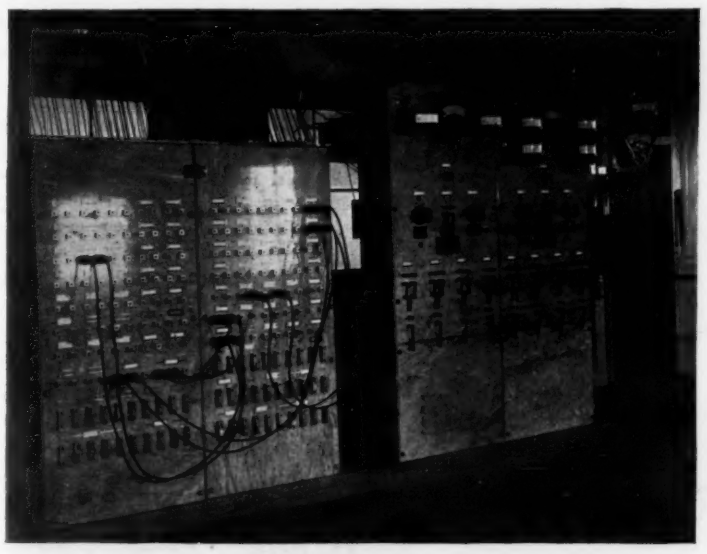


FIG. 5.—LABORATORY DISTRIBUTION AND ALTERNATOR SWITCHBOARDS.

various apparatus in the laboratory, are brought to a distributing switchboard, shown in Fig. 5. The terminals on this board are copper blocks with conical holes. Connections between the supply of current and the circuit which is to be fed are made by using taper plugs attached to flexible cords. A convenient feature of this board is that the terminals of several transformers and auto-converters are brought to it, so that an alternating-current pressure may be stepped up or stepped down in a great variety of ratios, simply by plugging in on the terminals of a suitable transformer.

Standardizing Laboratory.

A room 12 by 22 feet, seen in Fig. 6, is designated the Standardizing Laboratory. In this most of the work of delicacy or of high precision is done, including frequent intercomparisons of standards and checks of instruments used as working standards. The special feature of this room is the arrangement for reducing the relative humidity of the air within it. This is accomplished by pumping cold brine from the storage tank in the basement through radiator pipes placed near the ceiling of the room. These pipes are boxed in, a chimney extending downward from the box to a point near the floor. The hot, moist air near the ceiling of the room comes into contact with the cold pipes and deposits much of its moisture on them. Passing down through the chimney to the floor, it is reheated either by the walls of the room or by a steam radiator, whereby its relative humidity is greatly reduced.

The necessity for some such system is evident to all who have experienced the difficulties attendant upon electrical measurements of precision in this climate, particularly in Summer. With the high percentage of humidity which so frequently prevails, all insulators become coated with conducting films of moisture and stray electric currents passing into galvanometers interfere seriously with accurate work. The arrangement above described is capable of reducing the relative humidity of the standardizing laboratory from 85 per cent. to 65 per cent. in a relatively short time. The reduction in the tem-

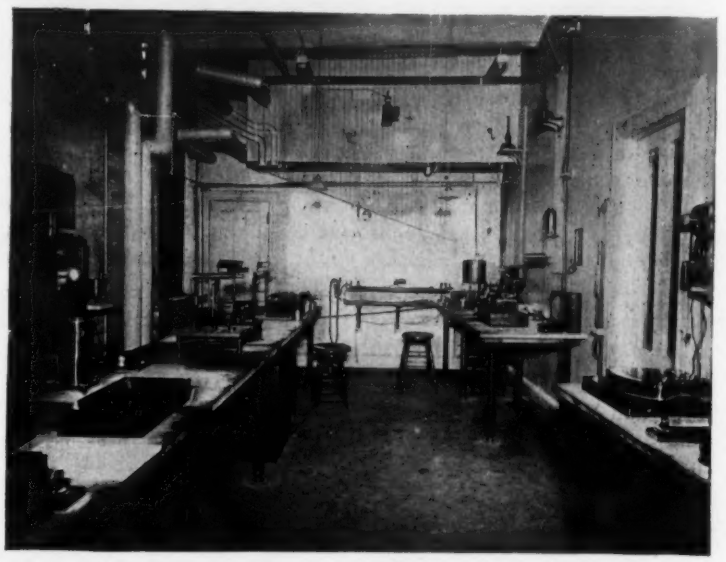


FIG. 6.—STANDARDIZING LABORATORY.

perature of the room is itself far from disagreeable in hot weather. The system has proved itself to be invaluable.

Resistance and Conductivity.

The equipment of the standardizing laboratory is chiefly for the measurement of resistance and of electromotive force. The standards of resistance used are of the Reichsanstalt pattern. These have been calibrated by the Reichsanstalt or by the National Bureau of Standards, or by both, and are of the highest accuracy. The set comprises multiples of ten from 0.0001 ohm to 100,000 ohms. The low resistance standards which are used for measurement of current by the fall of potential method constitute a series distinct from the above.

For the measurement of resistances of the ordinary ranges a five-decade Wheatstone bridge of the Anthony pattern is used. The values of the resistance of the coils of this bridge have all been determined by the National Bureau of Standards, so that measurements of any desired degree of accuracy may be made by it.

For the measurements of low resistances a Kelvin double-bridge by Wolff, of Berlin, is employed. The arrangement of this apparatus, which is more or less typical, is as follows: Current brought from large storage cells in the main laboratory is controlled by a carbon plate rheostat and measured by a Weston millivoltmeter and shunt. A double-pole double-throw switch rated at 100 amperes capacity, serves as a reversing switch. This, as well as all the other switches, is mounted directly on the stone top of the table and is back connected. The wiring is so carried out that comparison may be made by the bridge, either of two low-resistance standards, of a sample of wire and a manganin standard, or of a sample of wire and a standard wire of the same material. The leads from the potential terminals of the resistances to be compared to the bridge box pass through double-pole, double-throw switches by means of one pair of which their connections on the box may be interchanged and by the other pair of which the bridge currents are reversed.

In testing the conductivity of a sample of wire, the latter is clamped between jaws something over a meter apart, and the resistance of a portion between knife edges is measured. The distance between these knife edges is determined by a scale and vernier. The whole is immersed in an oil bath, which can be warmed or cooled by passing a stream of water through a pipe also immersed in it. In this way the temperature of the wire can be brought to any desired point and maintained there while measurements of its resistance are being made, and so its temperature coefficient determined. The results are readily expressed in terms of percentage conductivity.

The galvanometer is of the Siemens and Halske d'Arsonval type, with an arrangement for vertical projection of the spot of light, as follows: The galvanometer is placed on a shelf on the wall above the table. The incandescent lamp which is to furnish the spot is supported in front of the galvanometer and slightly higher than the mirror. In front of the galvanometer mirror and not far from it is a small mirror which throws the reflected beam downward on to a ground-glass scale. Another mirror, placed at 45° enables the scale to be seen from the other side of the table. This is a simple arrangement, easily adjusted and kept in order. It is preferable to the more complicated arrangements for accomplishing the same purpose.

Measurements of the resistance of insulating materials, of cables, etc., are made by the usual galvanometer method. For many purposes a high-resistance d'Arsonval galvanometer has a sufficiently high megohm constant. To meet cases where this is not sufficient, a high-resistance du Bois armored galvanometer is used. The armor of this galvanometer cuts down the effects of outside magnetic disturbances to about the one-thousandth part of their ordinary value. For still higher resistances an electrostatic voltmeter and condenser are used, the fall of charge method being employed.

Electromotive Force.

Measurements of electromotive force are made with a potentiometer and Weston standard cell. The latter is checked from time to time against Weston normal cells and Clark cells. A supply of such standard cells is on hand, they being both of foreign manufacture, and those made in the laboratory. Checks are made also using the silver voltameter. By such intercomparisons the accuracy of the fundamental standards is assured.

Voltmeter checks requiring high precision are made directly with the potentiometer and standard cell. To this class belong the checks made of the Weston laboratory standard voltmeter, which is kept in a fixed position in the standardizing laboratory. Ordinary checks of voltmeters are made against this instrument, correcting its indications according to a curve derived from the potentiometer measurements. This curve is plotted so as to show the deviations of the voltmeter indications from the true readings.

Provision is also made for the accurate measurement by the fall of potential method of the current passing through standardized incandescent lamps at their standard voltages.

Another useful piece of apparatus in the standardizing laboratory is a Callendar universal recorder, which is essentially a recording Wheatstone bridge or a recording potentiometer. This instrument is capable of recording the change in resistance of a conductor or the change of an e.m.f. Consequently, it can be used for making a record of all phenomena which can produce such changes, such as e.m.f. current strength, resistance, frequency, temperature, pressure, radiation, etc. For example, the e.m.f. of a battery under test will be recorded with accuracy by the apparatus directly used as a potentiometer. If, however, the changes of an alternating e.m.f. must be recorded, the latter is used to heat a fine platinum wire and the instrument records the changes in resistance of this wire. Its chief advantage is the high accuracy with which it records the phenomena and the wide range of work to which it is adapted.

Constant Temperature Room.

This is a room with lagged walls adjoining the standardizing laboratory. Cold brine pipes are connected to a radiator in the upper part of the room, the circulation of brine being controlled by a pneumatic thermostat. By this means the room can be held at any desired low temperature. For maintaining the room at a temperature higher than that of its surroundings, electric heaters also controlled by a thermostat are employed. In this room tests can be made of apparatus under different temperature conditions.

MAIN LABORATORY.

Alternating-Current Voltmeters.

The main laboratory is contained in one large room on the top floor. At a point convenient to the standardizing laboratory, apparatus is installed for the accurate measurement of alternating e.m.f's and for checking alternating-current voltmeters (Fig. 7). This consists in a Weston laboratory standard alternating-current voltmeter, Hartmann & Braun astatic electrodynamometer voltmeter, which can be read directly or by using a telescope and scale, and a Kelvin multicellular electrostatic voltmeter, which also can be read by means of a telescope and scale. Accurate determinations of alternating-current voltages are made by the use of the Kelvin electrostatic voltmeter. This is first calibrated on direct current, and then the alternating current is thrown on quickly without giving the needle time to fall to zero. By the use of this instrument inductance errors are avoided. The Hartmann & Braun instrument shows a

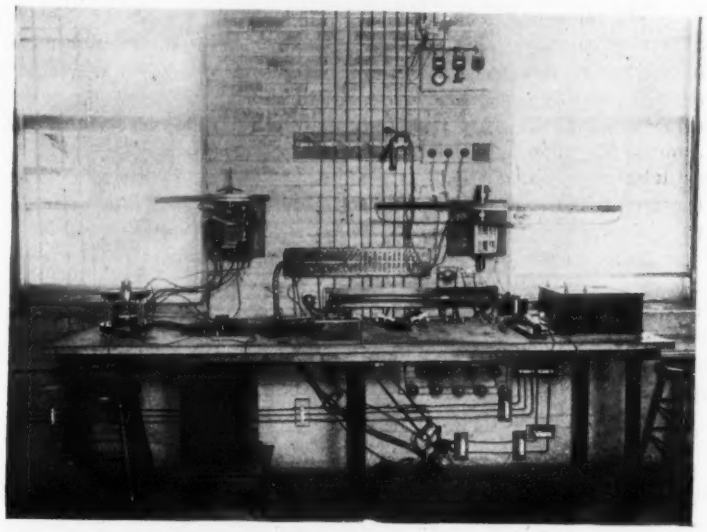


FIG. 7.—ALTERNATING-CURRENT VOLTAGE MEASUREMENTS.

very small inductance error. The Weston instrument, calibrated at various frequencies, is used as a working standard.

AMMETER AND WATTMETER TESTING.

For checking ammeters and wattmeters a special arrangement of testing tables is employed. The current supply is derived from four large cells of battery, which can be connected either in series or in parallel, and which are capable of delivering 5,000 amp.; from a low-voltage, heavy-current transformer, or from any other source in the laboratories. Terminals from the battery and from the transformer are brought to a switchboard (Fig. 8), to which also come the leads

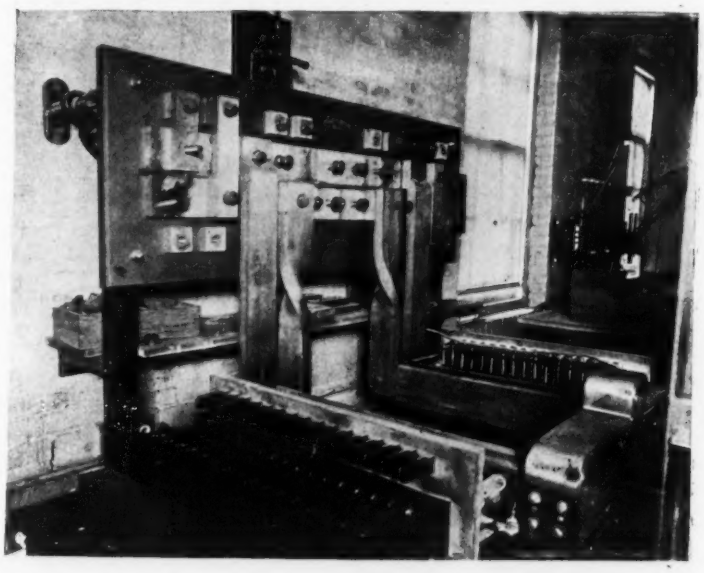


FIG. 8.—HEAVY CURRENT SWITCHBOARD AND RHEOSTATS.

from the testing tables. These leads are copper bars 1.5 by 4 inches. Connections are made by bolting on copper straps of similar cross section. One of the testing tables is designed primarily for testing recording meters. The other, shown in Fig. 9, carries the standard instruments, and is designed for the testing of indicating meters. Between each table and the switchboard is interposed a heavy-current rheostat. This is made of a series of stretched metallic strips, which can be connected in parallel into the circuit by means of knife switches. The finer regulation of current is obtained by a carbon plate rheostat in parallel with these strips. When none of the strips is connected in the circuit, the carbon plate rheostat carries the entire current, and gives close regulation down to small values of current. The current is conducted along the back of the testing table by

copper bars placed on edge and quite close together. The front bar is interrupted in a number of places so that instruments can be connected in the circuit. The breaks which are not bridged by instruments are closed by copper bars bolted on. For a part of the distance across the tables the size of the copper bars is 1.5 by 4 inches; for the rest of the way the size is 0.5 in. by 1 inch. The end connection between the front and back strips is made by a suitable loop of copper. The strips have been made very heavy in order that the drop of voltage on the system may be very small even with currents as large as 5,000 amperes. For very heavy currents the two rheostats are placed in parallel. By means of bridging pieces, an instrument on one table can be connected in series with an instrument on the other table.

On the standard instrument table are placed three Kelvin balances. These are set on a shelf raised above the table to such a height that the balances can be conveniently manipulated. The balances are used chiefly for the measurement of alternating currents. Other instruments for the measurement of alternating current are two Hartmann & Braun astatic electrodynamometers of 6 and 25 amperes range, respectively. Direct currents are measured by the fall of potential method with low-resistance manganin standards, oil and water cooled, the potential being determined by a potentiometer. The working standard is a Weston laboratory standard millivoltmeter, with a series of shunts. A standard wattmeter of the Duddell-Mather pattern has been ordered, but has not yet been received. This will also be installed on this table. This wattmeter should show a high degree of accuracy even with power factors as low as 5 per cent.

For the measurement of alternating-current volts, amperes and watts out of the ordinary range, a Rowland electrodynamometer with shunt-box is used. This instrument, which is seen in Fig. 8, is capable of measuring a very small fraction of a watt or ampere and can be used as a wattmeter on very low power factors. It is also available for use as a millivoltmeter in measuring very heavy alternating currents by the millivoltmeter and shunt method. A sensitive Ayrton-Mather electrostatic voltmeter is also available for measuring alternating currents by the use of a shunt.

For determining the wave-form of alternating currents a General Electric frequency meter is employed.

ALTERNATING-CURRENT CURVES.

For determining the wave form of alternating currents a General Electric wave meter is used. In this instrument (Fig. 10) a suitable contact-maker is driven by a synchronous motor fed by the dynamo which is to be tested. The contact-maker charges a condenser and discharges the same through a direct-current measuring instrument. The position of the brushes on the contact-maker can be shifted by 5 deg. steps, so as to cover an entire alternating-current wave. When it is desired to get the numerical values of the ordinates of the alternating-current curve for the purpose of determining the values of the harmonics present, a Weston voltmeter is used as the measuring instrument, and the values are obtained by reading the voltmeter at each point as the contact brush is shifted step by step from one end of a wave to the other. When a graphical record of the wave-form only is desired, it is obtained by using a photographic attachment. With this arrangement the deflections of a galvanometer are recorded on a photographic plate, which is moved across the field at the same rate as the contact brush is advanced. A reflected spot of light from an incandescent lamp impresses the record on the photographic plate. The contact-maker and the recorder are double, so that two simultaneous records can be taken, as, for example, of current and e.m.f. The photographic attachment with its galvanometers is mounted on a brick pier, as will be seen in Fig. 11. The synchronous motor with its appurtenances is placed on a stone top table alongside the pier, and the necessary switches and rheostats are attached to a stone slab mounted vertically on the legs of this table.

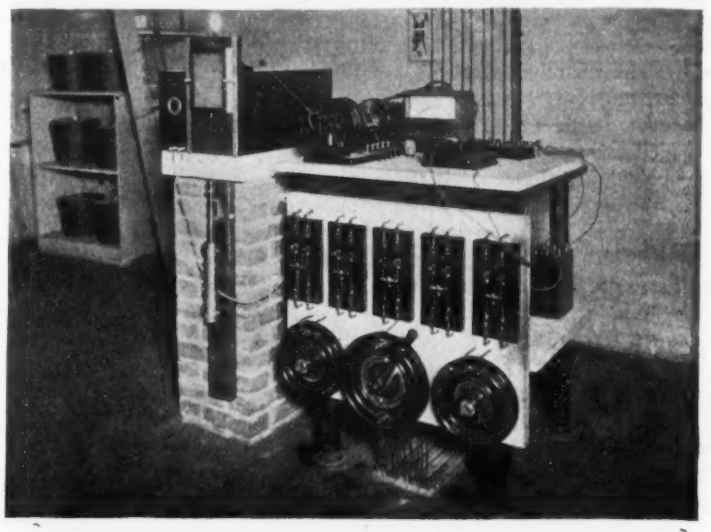


FIG. 10.—ALTERNATING-CURRENT WAVE METERS.

OSCILLOGRAPH.

When three records of alternating-current phenomena must be obtained simultaneously or when it is desired to study an instantaneous phenomenon which is not periodic, as, for example, the opening of a circuit-breaker or switch, resonance phenomena in transmission lines, commutation currents, etc. a triple oscillograph is employed. (Fig. 11.) This oscillograph is of the General Electric Company's make, and is similar in principle to the Duddell and Blondel oscillographs. In other words, it is a d'Arsonval galvanometer, with very light moving parts, having a very small moment of inertia, a very high period and being strongly damped. To secure these qualities, the moving part is made of a single loop of phosphor-bronze strip stretched

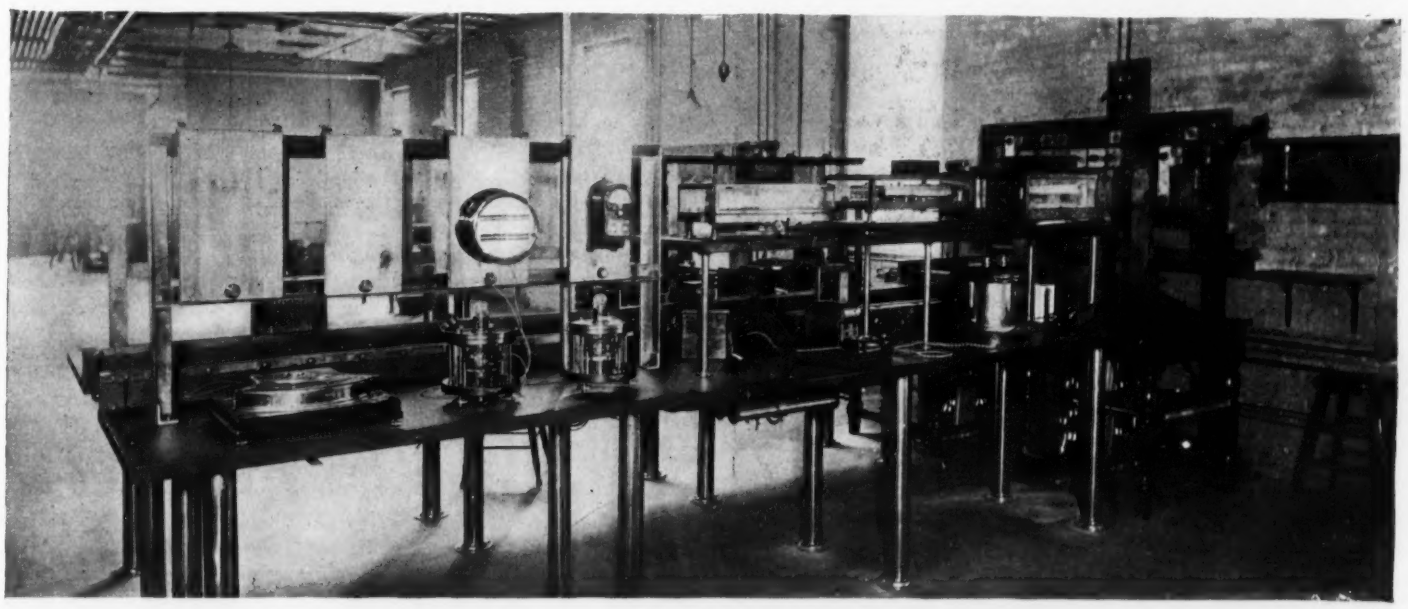


FIG. 9.—AMMETER AND WATTMETER TABLES.

tightly in the magnetic field. This little loop, the sides of which are less than a millimeter wide and about one millimeter apart, carries a minute mirror. It is immersed in oil, which produces the requisite damping. The magnetic field is a very powerful one produced by an electromagnet. Three such little galvanometers are mounted side by side. The light from a powerful arc in a projection lantern is reflected from the minute galvanometer mirror either to a photographic film wrapped around a revolving drum or to an oscillating mirror which throws the beam of light on a translucent screen and enables the wave-form to be seen. A record recently obtained by means of this oscillograph may be described as follows: The central line is the curve of the e.m.f. of a small rotary converter, the commutator of which was in such bad condition as to produce ripples on the curve. On one side of this curve is the record of the current driven by this e.m.f. through a coil of high inductance. The effect of this coil was to obliterate the ripples and to give a smooth wave, which is displaced in phase relatively to the e.m.f. curve. On the other side is the record of the charging current of a condenser placed in parallel with the inductance. Here the ripples are greatly exaggerated, while the main current wave is almost entirely obliterated. Since the fundamental frequency yielded by the rotary was 125 cycles per second, the oscillograph recording the condenser current was responding to currents of a frequency of about 3,600 cycles per second, which is an excellent illustration of the efficiency of the apparatus in recording phenomena of very high velocity. This apparatus is installed on a stone top table, with the necessary switches and rheostats arranged in switchboard fashion on the stone slab attached to the legs.

HIGH-TENSION TESTS.

The main sources of supply for high voltage testing are a 10-kw transformer rated at 120,000 volts, and five direct-current dynamos, which, when connected in series, give a maximum of 10,000 volts. Besides the 10-kw transformer, smaller transformers are available for lower voltages. Four pairs of leads are brought out from the high-tension transformer so that it will yield its total kw capacity with maximum voltages of 30, 60, 90 and 120 kilovolts.

An important feature of the equipment for high-tension testing is the arrangement for measuring the high-tension directly. The ordinary practice in such testing is to determine the high secondary voltage from the primary voltage, using the ratio of transformation of the transformer, or else to use a spark-gap as a voltmeter in the secondary circuit. Both methods may lead to considerable errors,

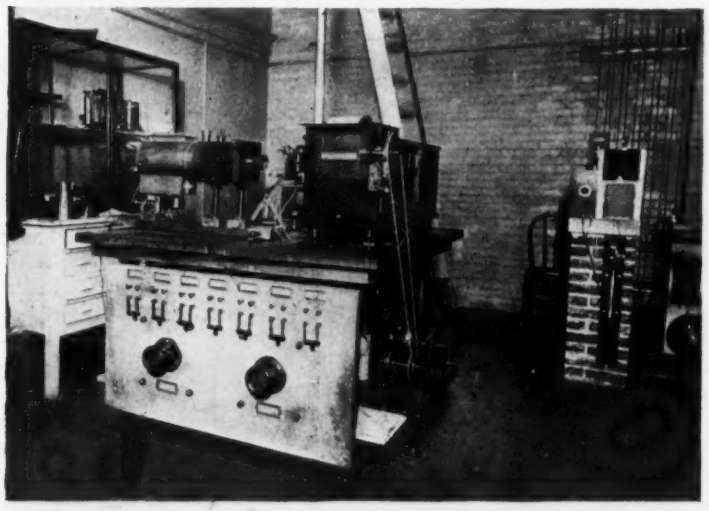


FIG. 11.—OSCILLOGRAPH.

the former when the charging current passing into the specimen to be tested is large, and the latter when atmospheric and other conditions change. To avoid these difficulties a Kelvin electrostatic voltmeter is used, measuring the high tension directly. Since, however, the maximum alternating-current voltage which can be used on this instrument is 35,000 volts, it is connected across only one of the four sections of the transformer. When all four sections of the transformer are in series, yielding a maximum of 120 kilovolts, the indications of the voltmeter are exactly one-fourth of the total voltage given by the transformer, hence from the voltmeter readings the total voltage is obtained by multiplying by four.

A suitable spark-gap is available for use when it is desirable to employ it. The high-tension direct-current machines of Crocker-Wheeler make, have a capacity of 500 watts each. A separate exciting dynamo is provided for each of these machines, the shafts of the dynamo and of the exciter being connected by flexible insulating couplings of rubber tubing. This arrangement relieves the insulation of the dynamos from the undue strains to which they would be subjected if the exciting currents for their fields were taken from a common source. The dynamos are driven by one motor and are insulated from it by their paper pulleys and leather belts. They are insulated from earth by placing them on stone slabs.

The importance of making direct-current puncture tests on materials which are to be used on direct-current is considerable.

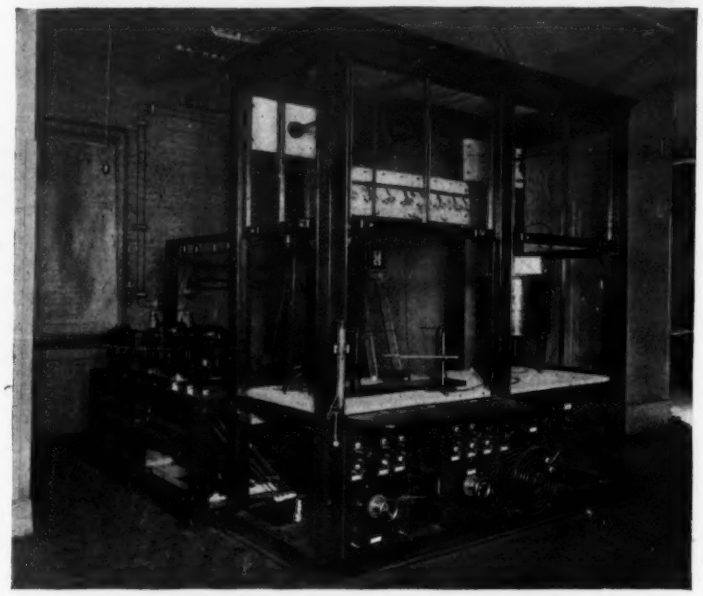


FIG. 12.—HIGH-TENSION CABINET AND GENERATORS.

This is due to the fact that dielectrics which show a large dielectric hysteresis, and consequently heating, under alternating-current tests, break down on alternating-current at much lower voltages than on direct-current. To get a full knowledge of the properties of any semi-solid insulator, it should be tested on direct-current as well as alternating current.

For handling the high-tension currents a special testing table is installed. This is made in the form of cabinet (Fig. 12) with glass windows. The leads from the high-tension transformer are brought through long hard-rubber bushings, attached to stone slabs on the back of the cabinet. The leads from the high-tension direct-current machines are brought to switch terminals attached to a stone slab also on the back of the cabinet. The Kelvin voltmeter, the spark-gap and the piece to be tested are placed on a stone slab within the cabinet. The control of the voltage of the high-tension transformers is obtained by adjusting a rheostat in series with the field of the alternator which furnishes the current, thus varying the impressed e.m.f. The control of the direct-current high-tension is obtained by field rheostats, and also by varying the speed of the motor. All of these rheostats and the necessary switches are conveniently installed on the front of the cabinet.

In view of the high tensions which are employed, particular attention has been given to insuring the safety of persons making high-tension tests, the arrangement being as follows: A single-pole knife switch has been placed in each leg of the primary circuit of the high-tension transformer. The handles of these switches project in such a way that the act of opening of either of the front windows of the cabinet, which must be opened in order to give access to any high-tension conductor, interrupts one leg or the other of the primary circuit. This circuit cannot again be closed until both windows have been lowered. In a similar way, raising either window automatically disconnects the lines from the high-tension, direct-current generators and renders them harmless. It also interrupts the secondary circuit of three 10,000-volt testing transformers which are installed beneath the cabinet, and which are used for lighter testing. With this arrangement it is impossible for the operator to come in contact with any live high-tension wire without deliberately going behind the cabinet and making an effort to do so. Current for the three small high-tension transformers is furnished by a small alternator driven by the same motor as drives the direct-current machines.

4000-Kw. Generators for the California Gas & Electric Corporation.

As recently noticed in our columns, the California Gas & Electric Corporation's station for the operation of the United Railways of San Francisco will be equipped with three 4,000-kw gas engine-driven generators.

The engines, which will be the largest yet made in the world, will be built by the Snow Steam Pump Company. The generators of the type developed by Brown, Boveri & Cie, in Switzerland, will be built by the Crocker-Wheeler Company. Each of the gas engine-driven generators will deliver 4,000 kw at 13,200 volts, will have a frequency of 25 cycles and run at 88 r.p.m.

In anticipation of more complete details of these machines, which we expect to publish later, we show in Figs. 1, 2 and 3 the preliminary designs of the apparatus.

It will be noticed that the housings are of the box girder construction common in this country, a sufficient amount of metal being put into the sections to prevent deflection from the weight of the parts or from unbalanced magnetic pull of the rotor, without resort to accessory stiffening arms or other similar devices.

The machines will not be built with formed windings applied in the usual manner from the internal surface of the core, but will be hand-wound, of flexible conductor, threaded through slots entirely sunken beneath the surface of the core and arched over.

To get at formed coil windings requires either side shifting of the frame, separation of the housing either vertically or horizontally, or the removal of the poles. All of these operations are undesirable, and especially the side shifting, which greatly increases the shaft length and floor space. Where rigidity in the shaft is particularly desirable as in gas engines, an increase of length is a great disadvantage, and in the present engines where the shaft diameter is 36 inches, it would be out of the question.

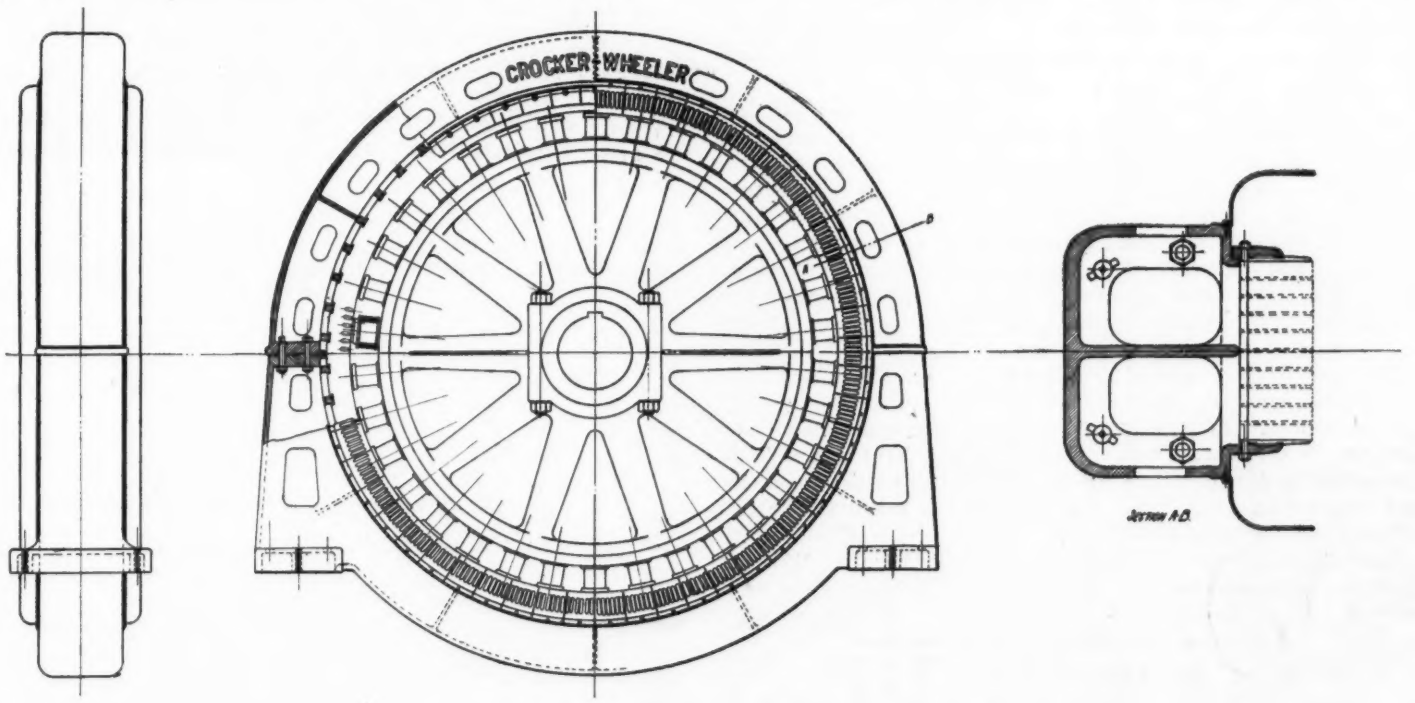
The threaded winding is more difficult to apply, but avoids the objectionable features above mentioned, and can be got at without disturbance of machine adjustments in any way. In the event of repairs, the replacing of a damaged coil does not, as in the case of form windings, disturb neighboring coils. Windings applied in place can make use of dense tubular insulation made separately from the coils, and subjected to processes that the coils as a whole would not stand. Such insulation is more rigid mechanically and more completely water-proof than the wrappings on formed coils.

The sinking of the windings below the core surface and the employment of arched slots, removes all eddy currents from the copper conductors, permits a very close approximation to true sine wave in e.m.f., and has other advantages.

The Brown, Boveri type of generator is particularly adapted to parallel operation, on account of its large inherent damping effects, and in the present machines the damping will be important, not only because they are to be driven by gas engines, but because their work will be railway load having considerable fluctuations.

The generators will regulate within 10 per cent. at unity power factor and develop a temperature rise of less than 40° C., and at full load and half load will have an efficiency of 96 and 93.5 per cent., respectively.

They will also be capable of working as motors in starting the engines that drive them, operating the compressors until the latter are ready to supply the proper explosive mixture.



FIGS. 1, 2 AND 3.—4000-KW GAS ENGINE ALTERNATOR.

More New York Subways Proposed.

In addition to the subway schemes before the public, Mr. William Barclay Parsons, as its chief engineer, submitted last week to the Rapid Transit Commission plans for additional lines in Manhattan, the Bronx and Brooklyn, which, if carried out, may go far toward solving the transit problem. The plans differ in several important respects from any heretofore submitted. In general the plans provide for a new East Side line, from the Battery to East One Hundred and Forty-ninth Street, in the Bronx, with a double-decker subway in Lexington Avenue; a new West Side line, from the Battery to Forty-second Street, connecting near there with the present subway; a crosstown connection at Thirty-fourth Street, between Seventh and Park Avenue; a diversion of the proposed Fourth Avenue line to Fort Hamilton in Brooklyn to Hamilton Avenue, thence under Buttermilk Channel to Governor's Island and to the Battery, and thence by tunnel under Greenwich Street to connect with a low level loop of the new West Side route at Barclay Street.

In the Bronx the plan proposes an extension of the present West Side line from Kingsbridge to Van Cortlandt Park, and an extension of the present East Side line from its terminus at One Hundred and Eightieth Street under Bronx Park to the city line. The plan advocates the extension of the elevated railway from One Hundred and Fifty-fifth Street on the West Side across the Harlem River and to Woodlawn; the building of two additional tracks on Second Avenue for express trains; the extension of the elevated lines in Brooklyn.

The estimated cost of the proposed new lines in Manhattan is about $40,000,000. The extension of the subway system in the Bronx and Brooklyn will involve an expense of about $9,000,000.

On Direct-Current Balancers.

BY A. E. KENNELLY AND S. E. WHITING.

WHEN either a three-wire or a four-wire direct-current system has to be supplied from a single main generator, as in Fig. 1, a motor-generator set is sometimes installed to supply the intermediate pressures. Thus if G (Fig. 1) is a shunt-wound or compound-wound generator supplying the outers, A, D, of a four-wire system, A, B, C, D, with a constant pressure, E, of say 600 volts; e_1, e_2 and e_3 may be three smaller and similar machines coupled together, as by a common shaft, in such a manner that while the triple machine, e_1, e_2, e_3, acts normally as a 600-volt shunt motor running idle, yet if load be connected between any pair of adjacent mains, the component machine connected therewith will supply the load as a secondary generator, being driven by its neighbors as its motors. Thus, each component armature, e_1, e_2, e_3, may maintain 200 volts on the mains $A\,B$, $B\,C$ and $C\,D$, respectively.

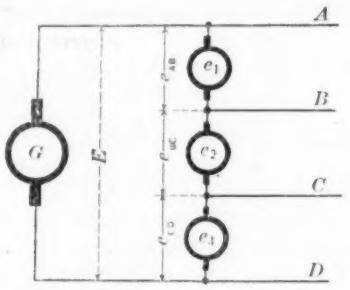


FIG. 1.—FOUR-WIRE BALANCER.

Such a motor-generator set is often called a "balancer," since it maintains automatically a balance between the power received from the outers, $A\,D$, at full pressure, as a motor, and the power which it delivers through the inners as a generator at a lower pressure. Moreover, it is well known that for the operation of systems of motors in factories, a suitable balancer set may often form, in the aggregate, a small machine by comparison with the main generator, G, so that a generator and balancer may be distinctly cheaper to install than the equivalent series of generators, such as belonged to the original type of multiple-wire system.

The quantitative laws of operation of balancers are both interesting and practically important. Since these machines are in use, they cannot fail to be more or less generally understood. The authors are not aware, however, that these laws have been definitely determined and published. It is the object of this article to express the fundamental conditions of operation of such balancers in a form adapted for use in engineering.

The simplest type of balancer is shown in Fig. 2. Here the generator, G, maintains a steady e.m.f., E, volts between the outers, A and C, of a three-wire system. Across these mains are two precisely similar shunt-wound machines, with their armatures mounted on a common shaft, and connected in series. The shunt fields are excited from the outers, either in series, as shown, or in parallel. So long as the system carries load across the outers only, as at I, the system will be virtually a two-wire system, and the balancer will run unloaded as a composite shunt motor. If the mechanical and magnetic frictions of the balancer rotor absorb p watts, we have:

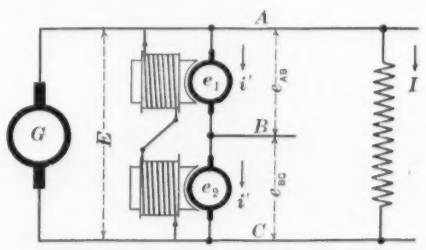


FIG. 2.—THREE-WIRE BALANCER, UNLOADED.

$$E - 2e - i'(2r) = 0 \qquad volts, \tag{1}$$

$$2e\,i' = p \qquad watts, \tag{2}$$

where r is the resistance in ohms of each armature, i' the current through each armature (amperes) and e the e.m.f. generated in each armature by rotation (volts). Thus, if E, the constant pressure between outers, were 200 volts; r, the resistance of each armature 0.1 ohm, and i', the current required to overcome the frictions 1 ampere, equation (1) shows that the drop of pressure in the armature resistances would be 0.2 volts, the c.e.m.f. of the balancer 199.8 volts, and of each armature 99.9 volts; while the power, p, expended in frictions would be 199.8 watts.

Next suppose a load of I_2 amperes applied, as shown in Fig. 3, between the mains $B\,C$. The component armature, e_2, of the balancer now becomes a generator for this load; while component e_1 becomes a motor to drive the generator. Denoting by i_2 and i_1 the currents in the two armatures, respectively, and assuming that the frictional losses in the rotor continue to absorb the same amount of power (200 watts), and current from the outers, as before, we have:

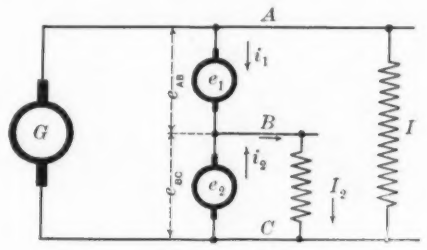


FIG. 3.—THREE-WIRE BALANCER, LOADED.

$$E - 2e - i_1 r + i_2 r = 0 \qquad volts. \tag{3}$$

At the point B the equation of incoming and outgoing current gives

$$i_1 + i_2 = I_2 \qquad amperes. \tag{4}$$

The power delivered by the generator-armature, e_2, is $e\,i_2$ watts. The power absorbed by the motor-armature, e_1, is $e\,i_1$ watts. Consequently,

$$e\,i_1 = e\,i_2 + p \qquad watts, \tag{5}$$

$$\therefore \quad i_1 = i_2 + \frac{p}{e} = i_2 + 2i' \qquad amperes. \tag{6}$$

From (6) and (4)

$$i_2 = \frac{I_2}{2} - i' \qquad amperes. \tag{7}$$

$$i_1 = \frac{I_2}{2} + i' \qquad " \tag{8}$$

From (3), (7) and (8)

$$E - 2e - 2i'r = 0 \qquad volts. \tag{9}$$

This is the same equation as (1). Consequently, the e.m.f. generated by each armature is not altered by the load, under the assumptions made. Half of the load current I_2, is supplied by the generator, e_2, and the other half comes from the main generator, through the motor armature, e_1. The interesting fact is, therefore, that only half of the load between the mains, $B\,C$, is supplied by the component machine connected with them. It is also curious that neither the generated e.m.f.s, nor the speed of the balancer, are altered by the application of the load.

Before applying the load I_2, the pressure on the two sides of the system was manifestly balanced, or equally divided. That is, the pressure between $A\,B$ was 100 volts, as also the pressure between $B\,C$. After the application of the load, however, the condition changes. The pressure between $A\,B$ is:

$$e_{AB} = e_1 + i_1 r \qquad volts. \tag{10}$$

since e_1 is a motor. The pressure between $B\,C$ is

$$e_{BC} = e_2 - i_2 r \qquad volts. \tag{11}$$

since e_2 is a generator. In the case considered, if $I_2 = 100$ amperes,

$$\begin{aligned} e_{AB} &= 99.9 + 51 \times 0.1 = 105.0 \ volts \\ e_{BC} &= 99.9 - 49 \times 0.1 = 95.0 \ " \\ e_{AC} &= E \qquad\qquad = 200.0 \ " \end{aligned}$$

The loaded side of the system would thus drop in pressure, and the unloaded side rise in pressure, in the same manner as in the ordinary three-wire distribution system supplied by two main generators in series.

The authors have checked these deductions in the case of a small experimental balancer formed of two 0.75-kw shunt machines, coupled together, and operated across 250-volt outers, one of the components being loaded up to nearly full load.

Instead of considering a two-component balancer for a three-wire system, as represented in Figs. 2 and 3, we may consider an n-component balancer for an $(n + 1)$-wire system, as represented in Fig. 4; where E is the constant e.m.f. between outers, as generated by the main generator, G. Let there be n components in the balancer, only four of these being indicated in the figure. Let all the components be precisely similar and coupled mechanically together. Let e be the e.m.f. (volts) generated in each and every component, and r be the internal resistance of each component (ohms).

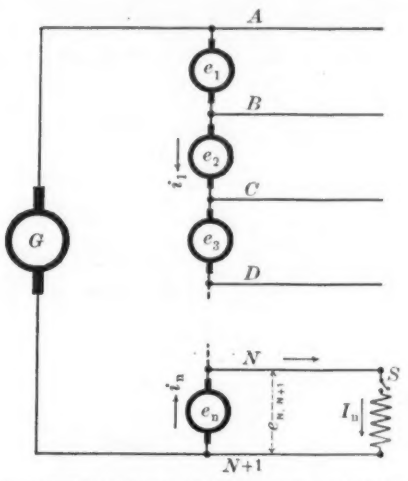


FIG. 4.—GENERALIZED BALANCER OF n COMPONENTS.

Let i' be, as before, the no-load current in the balancer to supply frictional losses.

I_n be the load current between the mains N and $N + 1$, when the switch, S, is closed.

Then, with the switch, S, open, and $I_n = 0$,

$$E - n\,e - i'nr = 0 \qquad volts, \qquad (12)$$

or

$$e = \frac{E}{n} - i'r \qquad " \qquad (13)$$

After closing the switch, S, and applying the load,

$$E - n\,e - i_1\,(n-1)\,r + i_n r = 0 \qquad volts, \qquad (14)$$

$$i_1 + i_n = I_n \qquad amperes, \qquad (15)$$

$$(n-1)\,e\,i_1 = e\,i_n + Ei' \qquad watts, \qquad (16)$$

The last term, $(E\,i')$, of equation (16) represents, strictly speaking, not only the frictional losses on no load, but also the I^2R losses of the armatures at no load. In all practical cases the error in this assumption is negligible. Equation (14) expresses Kirchoff's law of voltages in the circuit of the armatures; (15) expresses his law of currents at the branch point, N, and (16) the equality of the power absorbed by the $(n - 1)$ motors and the power generated by the single generator in addition to the frictional losses. In the equations (14), (15) and (16) E, n, r and I_n are supposed to be known. The unknown quantities are e, i_1 and i_n. Solving for these unknowns, we obtain:

$$i_1 = \frac{I_n}{n} + i' \qquad amperes, \qquad (17)$$

$$-\,i_n = I_n\left(1 - \frac{1}{n}\right) - i' \qquad " \qquad (18)$$

$$e = \frac{E}{n} - i'r \qquad volts. \qquad (19)$$

These equations show that if the frictions of the rotating system continue to call for the same power from the outers under all conditions of load, and also that the internal resistances, r, of the individual armatures remain constant, the outers supply $1/n$th of the load current, I_n, over and above the constant current of friction, i'. In other words, the main generator and outers supply the load at full pressure, E volts, and reduced current of approximately $\frac{I_n}{n}$ amperes, while the local mains supply the load at reduced pressure of approximately $\frac{E}{n}$ volts, and full current, I_n amperes. The balancer is, therefore, a direct-current transformer of electric power, and is the analogue in a direct-current system of the auto-transformer (Fig. 5), in an alternating-current system. The alternating-current generator, G, in Fig. 5, supplies a constant high pressure, E volts, to the outers, $A\,C$. These high-pressure mains supply an excitation current, i', to the auto-transformer, to satisfy its excitation losses, and also a working current, $\frac{I}{n}$ amperes, at full voltage, E. The low-pressure mains, $B\,C$, supply the full working current, I amperes, at the reduced pressure, $\frac{E}{n}$, approximately.

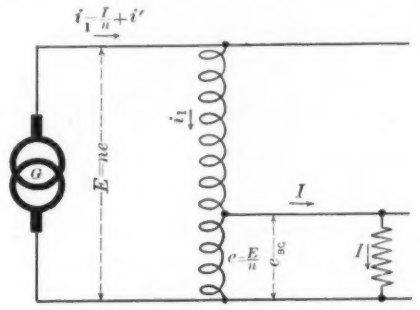


FIG. 5.—AUTOTRANSFORMER. A. C. ANALOGUE OF D. C. BALANCER.

We have hitherto considered a balancer, the components of which are all precisely similar. In practice, however, if the outer mains of a four-wire system, A, B, C, D, Fig. 6, maintain, say, 600 volts,

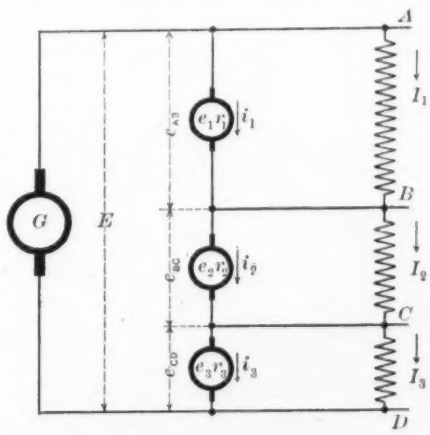


FIG. 6.—GENERALIZED BALANCER WITH DIFFERENT COMPONENTS.

$A\,B$ may have 200 volts, $B\,C$ 300 volts and $C\,D$ 100 volts. By such differentiation appropriately selected pairs of wires will give all pressures from + 600 to — 600 volts, inclusive, by successive steps of 100 volts. Such a gradation is useful, for example, in operating variable-speed shunt motors efficiently. Let the component machines in Fig. 6 have different e.m.f's and resistances, but let us assume that since the armatures are all rigidly connected in constantly excited fields that the *ratio* of e.m.f's in the different armatures remains constant, and that the respective internal resistances remain constant, under all loads. Let the power, $p = E\,i'$, expended by the outers in overcoming mechanical and magnetic frictions of the rotating system also remain constant at all loads.

Let E = the constant e.m.f. between outers (volts).

e_1, e_2, e_3 be the respective e.m.f's of components (volts).

$e_2 = n\,e_1$ and $e_2 = m\,e_1$ where n and m are constants.

r_1, r_2, r_3 be the respective armature and brush resistances (ohms).

I_1, I_2, I_3 be the respective loads on the components (amperes).

i' = the no-load current of frictions.

$r_1 + r_2 + r_3 = R$, the total resistance of the armature path (ohms).

$$\frac{1}{1+n+m} = a;\ \frac{n}{1+n+m} = b;\ \frac{m}{1+n+m} = c, \text{ so that}$$

$$a + b + c = 1.$$

Then by the same reasoning as in the preceding cases it will be found that:

$$\left.\begin{aligned} i_1 &= i' + (a-1)\,I_1 + b\,I_2 + c\,I_3 \\ i_2 &= i' + a\,I_1 + (b-1)\,I_2 + c\,I_3 \\ i_3 &= i' + a\,I_1 + b\,I_2 + (c-1)\,I_3 \end{aligned}\right\} \text{ amperes.} \qquad (20)$$

$$e_1 = \frac{E - R\,(i' + a\,I_1 + b\,I_2 + c\,I_3) + I_1 r_1 + I_2 r_2 + I_3 r_3}{1+n+m} \text{ volts} \qquad (21)$$

from which e_2 and e_3 are immediately determinable.

The voltages under load between the respective pairs of mains are:

$$\left.\begin{aligned} e_{AB} &= e_1 + i_1 r_1 \\ e_{BC} &= e_2 + i_2 r_2 \\ e_{CD} &= e_3 + i_3 r_3 \end{aligned}\right\} \text{ volts.} \qquad (22)$$

In all the equations, (20), (21) and (22), motor currents will be found to develop a positive value and generator currents a negative value. The equations also show that if

$$\frac{e_1}{r_1} = \frac{e_2}{r_2} = \frac{e_3}{r_3} \text{ amperes,} \qquad (23)$$

the values of e_1, e_2 and e_3, as determined by (21), do not change by the application of the loads, I_1, I_2, I_3; or any of them. But if the equation (23) does not apply, then the voltages and speeds of rotation of the balancer will, in general, be subject to some variation under loads. A balancer possessing the property of equation (23) may be called a *symmetrical balancer*, and one in which the equation does not apply, a *dissymmetrical* balancer. Consequently, symmetrical balancers do not vary in speed under variations of load, if the conditions taken in the assumptions duly apply.

As an example, we may consider a four-wire system, such as is represented in Fig. 6, in which $E = 600$ volts. The minor voltages may be $e_{AB} = 100$ volts; $e_{BC} = 300$ volts, and $e_{CD} = 200$ volts, respectively, under no load. Consequently, $n = 3$ and $m = 2$. Moreover, if the friction current, $i' = 3$ amperes, $r_1 = 0.1$ ohm, $r_2 = 1$ ohm; $r_3 = 0.4$ ohm; $R = 1.5$ ohm, the balancer is dissymmetrical, because

$$\frac{e_1}{r_1} = 1{,}000 \text{ amperes;}\quad \frac{e_2}{r_2} = 300;\quad \frac{e_3}{r_3} = 500.$$

Let $I_1 = 0$; $I_2 = 60$ amperes; $I_3 = 90$ amperes; so that

$a = \frac{1}{6}$; $b = \frac{1}{2}$; $c = \frac{1}{3}$. Then by (20),

$$i_1 = 3 + 0 + 0.5 \times 60 + 0.33 \times 90 = +63 \text{ amperes.}$$
$$i_2 = 3 + 0 - 0.5 \times 60 + 0.33 \times 90 = +3 \text{ amperes.}$$
$$i_3 = 3 + 0 + 0.5 \times 60 - 0.66 \times 90 = -27 \text{ amperes.}$$

In this case e_1 and e_2 are motors and e_3 the generator.

$$e_1 = \frac{600 - 1.5\,(3 + 0 + 30 + 30) + 0 + 60 + 36}{6} = 100.25 \text{ volts.}$$

$\therefore$ $e_2 = 300.75$ volts (3×100.25),
and $e_3 = 200.5$ volts (2×100.25);

while at no load, by making $I_1 = I_2 = I_3 = 0$,

$$e_1 = \frac{600 - 1.5 \times 3}{6} = \frac{595.5}{6} = 99.25 \text{ volts.}$$

In this case the application of the loads will *increase* the speed of the balancer about 1 per cent.

For the voltages between mains under load, by (22), we have:

$$e_{AB} = 100.25 + 0.1 \times 63 = 106.55 \text{ volts.}$$
$$e_{BC} = 300.75 + 1 \times 3 = 303.75 \text{ "}$$
$$e_{CD} = 200.5 - 0.4 \times 27 = 189.7 \text{ "}$$
$$e_{AD} = E = 600.00 \text{ "}$$

The formulæ, (20), (21) and (22) are general, and will apply to any shunt-wound balancer on a constant-potential system, with constant loss in frictions and constant internal resistances. They may be readily extended, by inspection, to cover any number of components or wires; the terms in the different equations being capable of generalization, as follows:

$$i_m = i' + a\,I_1 + b\,I_2 + \quad + (m-1)\,I_m + \quad + n\,I_n \text{ amperes.}$$

$$e_1 = \frac{E - R\,(i' + \Sigma n\ \Sigma m) + \Sigma}{1 + \Sigma n} \text{ volts.}$$

A Loose Leaf Consumer's Register.

By W. H. Winslow.

The form of loose-leaf electric consumer's register, a specimen page of which is reproduced herewith, is the outcome of fifteen years' experimenting and has been found highly satisfactory. At first it was made with a regular sewed binding, but later the loose leaf form was adopted and has been found a great improvement. The cost is much less, as the binders last for years, and there is none of the waste of unused pages which is inevitable with the bound book. The loose leaf book is also less bulky, containing as it does only the number of leaves in actual use. There are other advantages, but the merits of loose leaf books are now too well known to need further mention.

The company for whose use this form was designed is located in a city where, owing to the floating nature of the population, changes in the accounts are very numerous, and it was not thought practicable to have the register last more than a year; accordingly cut leaves were avoided, the monthly columns being condensed to permit of an entire year being covered on one page. Where changes are infrequent, a cut leaf could be used to advantage, designed to cover six months and making it unnecessary to rewrite the names every year. In the writer's opinion, however, the annual rearrangement of accounts to correspond with the reading cards is a great advantage. The same form is used for metered, monthly rate, series arc and power accounts.

It will be noticed that the first column is headed "From register number," which is, of course, the number of the account on the preceding register; the last column of the right-hand leaf is headed, "To register number," which gives the corresponding reference to the register for the succeeding year. One great advantage of this form of register, as compared with the regular ledger form with from one to four accounts to a page, is that the footing of a comparatively few pages gives, without the drawing off of any figures, the total kilowatt-hours accounted for, the total of the bills for the month to be charged to "electric register" on the general ledger, the total "arrears" to check against the "electric register" balance on the general ledger and the totals under "discount" and "amount paid" to check against the cash book.

As practice differs somewhat in respect to the handling of charges to the general ledger, I will say that the plan used in connection with this register is as follows: The total on the register under "amount of bill," which is the gross total, is charged to "electric register" and credited to "electric revenue" on the general ledger. As the bills are paid both the "discount" and the "amount paid" are entered on the blotter cash and the sum of the two daily totals entered on the debit side of the general cash book under "electric register," while the total of discounts for the day are entered on the credit side of the cash book under "electric revenue—discounts." From this it will be seen that the monthly trial balance will show as a debit to "electric register" the gross bills unpaid, while the credit to "electric revenue" will be fictitious to the extent of the discounts to be allowed on the one month's business. If considered necessary this can be corrected by a journal entry debiting "electric revenue" and crediting "reserve for discounts," to be reversed after taking off the trial balance. If this is not done it is, of course, necessary when making up the profit and loss entry at the close of the fiscal year,

to leave a sum to the credit of "electric revenue" sufficient to provide for the estimated sum of discounts to be allowed.

In connection with the form of register here advocated, it may be asked whether it has any advantages as compared with the card ledger. I think that it has. The card system is admirably suited for a petty ledger where entries are made in less time than it takes to find the account in an ordinary ledger. But with the register the case is quite different; there the bills are debited in order—that is to say, the fifty accounts on each page of the loose leaf form are entered one after the other without any loss of time, while with the card ledger fifty cards have to be taken from and returned to their drawer. In posting credits the difference is not quite so marked, but where bills with coupons are used and these sorted in order before listing on the cash book, the saving of time is still considerable, as the bulk of the payments are made usually on a few days, so that there are a number of postings, as a rule, to each page. This saving, together with the fact that with cards the data must be drawn off to secure totals, puts the card ledger in second place as regards economy of labor.

Electric Register "J" — January 1904

From Register No.	NO.	NAME	LOCATION	Rate	Min. Rate	Lamps	METER Badge	METER Date Set	METER Order No.	Dec. Read'g	Jan'y Read'g	Constant	Consumption	Amount of Bill	Arrears	Date Paid Feb.	Discount	Amount Paid
										K.W.H	K.W.H.		K.W.H.					
78	101	W. A. Whitney	1604 Ogden ave		95	1. 16 8. 8 16. 16	756	11/1/02	9450	388	417		29	3 62		9	72	2 90
79	102	J. P. Knowles	1606 " "		155	1. 16 24. 16 2. 32	766	11/15/02	9510	429	465		36	4 50		10	90	3 60
81	103	Jas. Wilson	1608 " "		140	25 16 8	784	2/5/03	9954	460	540	½	40	5 00	3 75	8	1 00	7 75
		18½ × 27½ 50 accounts to the page.	Jan.-May on left page Jun.-Dec. " right "															

LOOSE LEAF CONSUMERS' REGISTER.

Long Island City Power House of the Pennsylvania Railroad.

The Long Island power house of the Pennsylvania Railroad, located near the East River water front of Long Island City opposite Thirty-eighth Street, New York, is designed to supply power for the lines now being equipped with electricity by the Long Island Railroad Company and for future power for the operation of trains through the East River tunnel. The present power house building, the dimensions of which are 200 ft. by 265 ft., occupies but half of the site acquired for power house purposes. The present installation consists of three 5,500-kw turbo-generators, which will be used for supplying power to the Atlantic Avenue and Rockaway Divisions of the Long Island Railroad. The station as laid out, however, provides for six 5,500-kw units for traction purposes and two 2,500-kw turbo-generators for furnishing light in the tunnels and terminal buildings when these are completed.

The accompanying map shows in heavy lines the divisions of the Long Island Railroad which have been selected as the first to be operated electrically. The total line to be thus equipped is 86 miles, as measured in single track, and includes the Atlantic Avenue line from Flatbush Avenue to Jamaica and to Belmont Park, 14.12 miles; the Rockaway Division from Woodhaven Junction to Rockaway Park, 8.53 miles, and the line from Jamaica to the Metropolitan race track, 2.6 miles. The Ocean Avenue line between Rockaway Park and Far Rockaway has been operated by electricity for some time, but its capacity will be increased by a loop which has been built over the boulevard on the beach.

The turbines are the Westinghouse-Parsons horizontal type, each having an overload capacity of over 11,000 hp. Each generator is direct-connected to the turbine shaft through a flexible coupling, and will deliver three-phase currents at 25 cycles and 11,000 volts. Each unit will be capable of delivering 8,250 kw for short periods and considerably more during momentary periods of peak load.

Transmission lines will take the current directly from the machines at 11,000 volts, no step-up transformers being used. The high-tension current will be carried partly by overhead and partly by underground lines to sub-stations, where it will be transformed and converted into direct current at 625 volts.

The plans provide for eight sub-stations located along the Long Island system, but for the present only five of these stations will be equipped to provide for the service above mentioned. The map shows the location of these sub-stations. The Grand Avenue and East New York sub-stations will each have three 1,000-kw rotary converters, and nine 375-kw transformers. The Woodhaven station will have the same number of converters and nine 550-kw transformers. The Rockaway Junction and Hammels stations will each have two 1,000-kw converters and six 375-kw transformers, while the last mentioned will have, in addition, one 3,200-amp.-hour storage battery.

An interesting feature of the equipment will be two portable sub-stations mounted on cars and designed to be shifted to various parts of the system as load conditions may require. Each of the portable outfits will consist of a 1,000-kw converter, with transformers and all of the equipment necessary to make the sub-station complete in every detail, all compactly mounted on a car of regulation dimensions. These movable equipments will be of particular service in handling heavy race track loads, the amount of travel to any one of the several tracks not being of sufficient duration to justify permanent investments in sub-station equipments for each track. The portable equipment can also be side-tracked at any of the permanent sub-stations in the event of a breakdown or while repairs are being made to the latter.

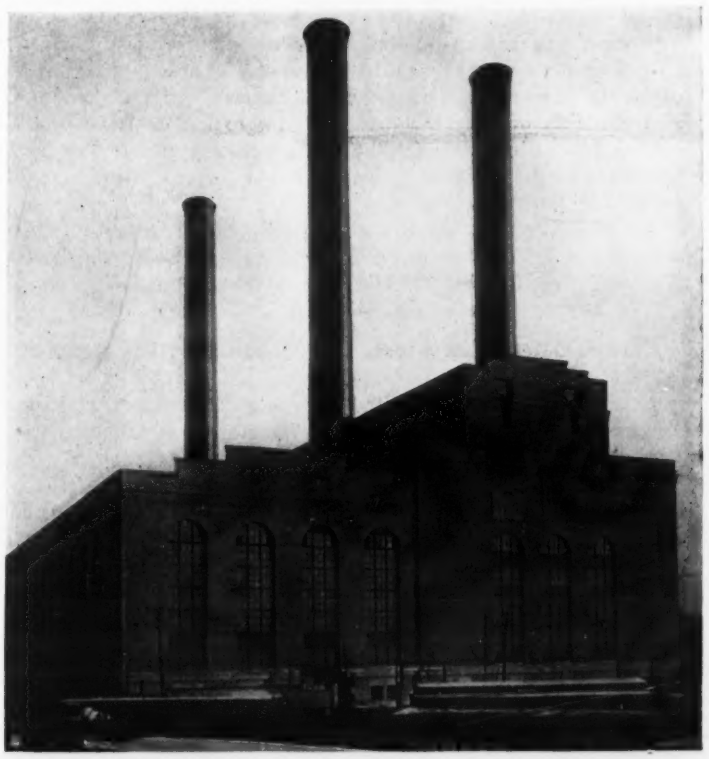


FIG. I.—VIEW OF POWER HOUSE.

The power house is divided into two equal portions by a division wall down the center, the boilers occupying one portion and the

machinery the other portion. A special feature in the construction of the power house is the extensive use of wire glass in the windows and skylights. Altogether about 30,000 ft. of Mississippi wire glass and angle iron frames were used in the windows, and about 5,000 sq. ft. in the skylights. The several transformer stations are also fitted with this material. The bunkers are located over the boiler

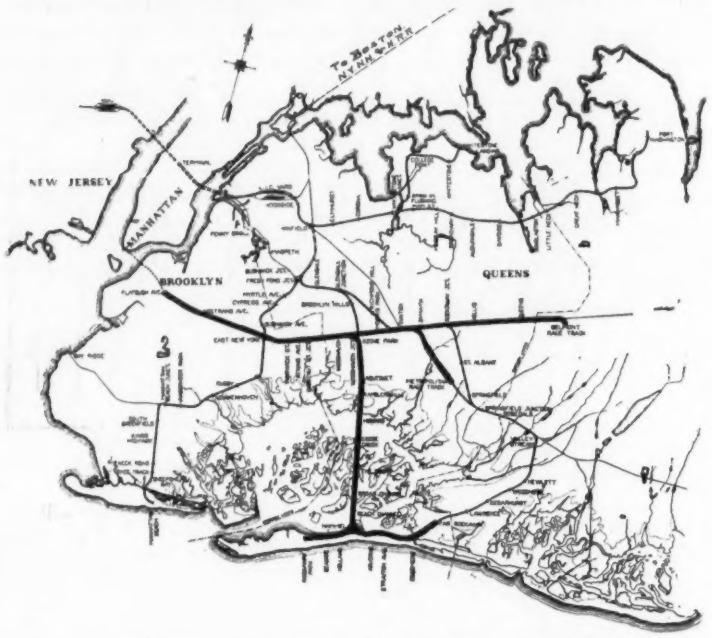


FIG. 2.—TERRITORY TO BE SERVED BY THE ELECTRIFIED DIVISION OF THE LONG ISLAND RAILROAD.

rooms and have a capacity of 10,000 tons of coal. They will be served by a coal conveyor which will take coal from barges and carry it across Front Street at a height of 175 ft. above the street level; the coal will then be discharged through a coal breaker into the hoppers. The ashes will also be removed by a conveyor system, the refuse being taken from under the boilers and dumped into cars of the Long Island Railroad.

Ground was broken on the site of the power house October 26, 1903, and the first pile was driven about a month later. The work of laying the concrete bed was commenced in January, 1904, and in the month of May the first bricks were laid and the first steel column placed in position. The first generating unit is now in place and most of the remaining machinery is either on the ground or in transit.

All of the engineering and construction of the power station was carried out by Westinghouse, Church, Kerr & Co., acting as engineers and constructors for the Pennsylvania Railroad.

The Consulting vs. the Designing Engineer.

In a recent discussion before the American Institute of Electrical Engineers, one of those taking part in referring to criticisms on an engineering paper from the designing engineer's standpoint said that the consulting engineer has to view a problem from the standpoint of the interest of those with whom they have to deal. Large enterprises, he said, are apt to be handled by consulting engineers rather than by designing engineers, and it goes without saying that the former cannot be expected to view the peculiarities of any apparatus from the peculiar standpoint of the designer. The minutiæ of design do not appeal to him. He is looking toward the net result of the apparatus as a whole and its relation to the entire system. He is obliged to view the entire enterprise in perspective and to expend his energies in selecting apparatus in some reasonable proportion to the relative importance of each part. He therefore is on the lookout for any reasonable short method that will give him a concise and comprehensive view of the effect on any apparatus of some particular duty. It often happens that the consulting engineer has to work out a large number of alternative schemes, and the shorter and more concise he can make his methods of comparison, the better he will be able to arrive at the correct conclusion. And a conclusion thus arrived at, it might have been added, is apt to be much more sound than one based on more exact but also more restricted considerations.

Recent Developments in the Electrostatic Separator.

By Woolsey McA. Johnson.

LATELY great progress has been made in concentrating lean ores by taking advantage of different degrees of the physical properties possessed by the constituents of the ores. Ore-dressing is usually cheap, and though the losses are often high, this cheapness makes for efficiency.

Of course, the oldest method is simple mechanical concentration by water, due to different specific gravities of different minerals. The jig, buddle, vanner, etc., are all old forms. In the past ten years the magnetic separator has been brought to the stage of being a standard machine in its various types, such as the Wetherill and Cleveland-Knowles. Of even greater importance was the advent of the shaking tables for the treatment of slimes. These have practically revolutionized ore-dressing. The several oil processes add to the complexity of the subject. Finally we see in the process of commercial evolution the separator based on the electrostatic repulsion of minerals.

Most of the sulfides of the heavy metals possess a metallic lustre. Those which do, conduct electricity to some extent. Their conductivity is not to be compared to that of the metals or even to that of carbon. Nevertheless, the sulfides of lead, iron, silver, etc., do conduct many times better than zinc sulfide, silica, etc.

Consequently, when in contact with a charged metal surface they rapidly assume a charge whose potential is equal to the potential of the plate. Thus, they are repelled violently. Minerals that are nearer the class of insulators will, however, take considerable time to come to the same potential. Therefore, when ore is allowed to fall down an inclined charged plate, the particles of high conductivity will be thrown several inches, while the particles of low conductivity will drop vertically from the lower edge of the plate.

The above principle is the basis of an electrostatic separator invented by Prof. L. I. Blake, of the University of Kansas, in conjunction with Mr. L. N. Morscher. Mr. W. G. Swart has worked out to a large extent the essential practical details. Several mills have been equipped with Blake-Morscher separators. At one of the largest mills, that of the Colorado Zinc Company, at Denver, the writer spent considerable time a year ago. There are several other installations in Colorado and Wisconsin. For a detailed description, the reader is referred to the *Engineering and Mining Journal*, January 24, 1903.

The ore used at Denver is mined at Leadville, Colo. It is too high in zinc for the lead smelter and too high in lead and iron and too low in zinc for the zinc smelter. It is crushed, screened and passed over wilfley tables. This operation makes a partial separation of the lead, iron, zinc and silica. The middle product containing zinc, iron and some lead is dried and passed through two Wetherill magnetic separators. The zinc sulfide, chemically combined with 10 per cent. of iron and known as "marmotite" is magnetic, while the iron pyrites is non-magnetic. The magnetic heads analyzed 45-47 per cent. zinc and are a very acceptable product to the Kansas zinc smelters.

The tailings containing zinc sulfide and iron pyrites are passed over the Blake machine. Here a second separation is made. A zinc product is sold to the Kansas zinc smelters while the iron pyrites containing some silver and gold is sold to the lead smelter, both for the precious metals and for a flux. Many refinements and improvements have been made, but there is still great room for improvement. Obviously the machine will not operate as well in a climate like that of Wisconsin as in a dry place like Colorado. A mistake was made at first in putting the Wimhurst machines and the separators in the same room with the driers and wet tables.

Especial progress will be made along the lines of carefully sizing the ore before it is sent to the electrostatic separators. Mr. Edison once told the writer, is the prime requisite for good work in concentrating plants.

A vast field awaits the electrostatic separator when once worked out to something nearer perfection. For instance, somewhat promising experiments have been made in treating the tailings of the Lake Superior copper mines. But like all other new developments there is always a lag between the impressed force of progress and the practical flow of results. However, even these accomplished facts are an interesting application of the first-known electrical phenomenon to electrometallurgical methods.

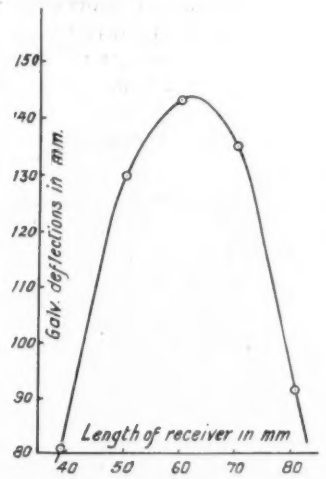
The Tuning of Thermoelectric Receivers for Electric Waves.

BY A. D. COLE.*

IN some earlier work with electric waves the writer used a modified form of Righi exciter, in which the two central spheres of the ordinary form were replaced by thin cylinders with rounded ends. The purpose of the present experiments was to find the best length of receiver for a given length of the kind of exciter used and the corresponding wave length. The active cylinders of the two exciters used were each 3.1 mm. in diameter and 25 mm. long in one and 37 mm. in the other, the total length being thus 50 or 74 mm. The receiver had cylinders of the same diameter, with a thermoelectric junction of fine iron and constantin wires between them. Its length could be varied quickly and without disturbing adjustments by sliding tubes of thin copper over the cylindrical ends. With this, deflections of 300 scale divisions or more were readily obtained. A galvanometer of 5 ohms-resistance and figure of merit 4.7×10^{-9} was used.

To facilitate adjustments the receiver was mounted behind a cylindrical lens instead of being placed in the usual parabolic mirror. This "lens" was a two-liter bottle filled with benzine. Its concentrating power was such that five times as large a deflection was obtained with the lens as without it.

The receiver length was changed from 39 mm. to 81 mm. by steps of about 10 mm. A maximum effect was obtained when the receiver was about 20 per cent. longer than the exciter. In a typical case, with exciter 50 mm. long the maximum occurred with the receiver



TUNING OF THERMOELECTRIC RECEIVERS.

62 mm. long. The deflection was 10 per cent smaller when the receiver was of the same length as the exciter. (See illustration.)

Wave lengths were measured by three interference methods which gave results in fairly good agreement: First, by reflection from a plane mirror behind the receiver, as in Hertz's experiment; second, by reflection on a plane mirror behind the exciter, and third, by Boltzmann's two-mirror method. (In a curve shown illustrating the second method, maxima occurred when the mirror was 14.0, 23.6 and 32.0 cm. behind the exciter and minima at 9.0, 18.5, 28.0 and 37.5 —intervals 9.6, 9.4, 9.5, 9.5, 9.5, mean 9.5, giving $\lambda = 19.0$ cm.).

Very different interpretations of such curves have been given by different workers. Hertz and Zehnder regard them as a measure of the wave length of the radiation given out by the exciter. Sarasin and de la Rive and Klemmencic and Czermak have shown that the dimensions of the receiver determine the form of the curve. Hull concludes that the curve depends on both exciter and receiver, and Willard and Woodman reach a similar conclusion. The different results of these observers are doubtless due in part to the different kinds of exciters, receivers and modes of interference used. With our apparatus the results clearly show that the wave length measured is that of the receiver. For instance, exciter 74 mm. and receiver 75 gave $\lambda = 188$ mm.; exciter 74 mm. and receiver 83 gave $\lambda = 220$ mm.; and exciter 50 mm. and receiver 75 gave $\lambda = 184$ mm.

*A paper presented at the Philadelphia meeting of the American Association for the Advancement of Science.

In the above experiments the plane mirror was behind the receiver. A curve is given to show that essentially the same form of interference curve is obtained when the mirror is placed behind the exciter.

The conclusions are as follows:

1. When the receiver is of the thermojunction type and linear form the three interference methods used show the wave length of the receiver.

2. When the receiver length is changed until a distinct maximum is obtained with a given exciter, the fundamental wave length of each is the same and an interference experiment will then give the wave length of the exciter.

3. The ratios of measured wave length to receiver length in five experiments (2.53, 2.51, 2.65, 2.45 and 2.47, mean 2.52) agree well with this ratio as determined theoretically by MacDonald (2.53) and not with the value (2.0) given by Poincarè.

The above experiments were performed during the past summer at Ryerson Laboratory, University of Chicago, and the author is much indebted to Assistant Professor R. A. Millikan for placing the resources of the laboratory at his disposal and for his personal interest in the work.

The Ratio Between Electrical and Gravitational Forces.*

BY BERGEN DAVIS.

THE nature of most attraction is of the highest interest to the physicist. Since the time of Newton, who demonstrated the law of gravitation and its universality, there has been almost no contribution to our knowledge of the mechanism of this force.

The more recent advancements of physical science have extended our knowledge of matter to its ultimate constitution. The hypothesis of the electronic constitution of matter is now well established. This matter, exhibiting mass attraction, is probably an aggregate of electrons, which exhibit electrical forces. The present paper is an attempt to show the most probable relation between these two forces acting between masses in two states of aggregation.

The relation between the electrical forces of two electrons and their mass attraction may be found from the most probable values of the relation of the charge to the mass of the electron.

The gravitational force between two masses, m m, is

$$F = k \frac{m^2}{r^2}, \qquad (1)$$

where k is the constant of gravitation.

The electrical force between two charges, e, is

$$f = \frac{1}{k} \frac{e^2}{r^2}, \qquad (2)$$

where k is the dielectric constant of the ether on the electromagnetic system.

The ratio of the charge of the electron to its mass has been measured by a number of physicists. Some of the values obtained are as follows: Kaufmann (1898), 1.86×10^7; Simon (1899), 1.865×10^7; Lenard (1899), 1.15×10^7; Kaufmann (1901), 1.31×10^7; Wichert (1899), 1.42×10^7.

The mean of the above values is $e/m = 1.52 \times 10^7$ electromagnetic units.

More recently A. Wehnelt has made a redetermination of this ratio, for slow-moving cathode rays, and obtained $e/m = 1.49 \times 10^7$ *e.m.* as an average of a number of observations.

P. Drude (*Annalen.*, No. 9, 1904), from considerations of optical phenomena, gives $e/m = 1.5 \times 10^7$ *e.m.* as the most probable value.

In this investigation I have taken $e/m = 1.52 \times 10^7$ as the most probable value of a constant of nature not yet well determined.

The electron carries a charge, and matter, as we know it, is neutral as regards charge. The assumption is made that in the atom the electron is associated with an equal amount of positive electricity (Kelvin-Thomson atom). If this positive electricity has mass, then

*A paper read at the Philadelphia meeting of the American Association for the Advancement of Science.

combined with one charge of one kind, there will be two masses of m each. So

$$e/2m = .76 \times 10^7,$$

where e is the quantity of electricity of each kind associated with two masses, m, each.

The gravitating force between masses is

$$F = k \frac{(2m)^2}{r^2}$$

and the electrical force is

$$f = \frac{1}{K} \frac{e^2}{r^2}$$

and their ratio is

$$\frac{1}{kK} \left(\frac{e}{2m} \right)^2$$

The gravitational constant, k, on the gram, centimeter system is $6{,}673 \times 10^{-11}$, and the value of K on the electromagnetic system is

$$K = (3 \times 10^{10})^{-2},$$

from which, on substituting, we have

$$\frac{f}{F} = (3 \times 10^{10})^4.$$

That is, the ratio of the electrical force between all the electricity of one kind associated with a given mass, to the mass force, is a number which is equal to the fourth power of the velocity of light in centimeters.

This ratio is a number and has no dimensions. It is independent of the unit of length, and so is probably not connected with K, the dielectric constant of the ether, since although the dimensions of K are unknown, yet it must involve a length.

New Telephone Patents.

NEW SWITCHBOARD CIRCUITS.

The two-wire common battery system has appeared in new form, this time in a patent granted to J. G. Roberts, of Detroit, assigned to the Kellogg Switchboard & Supply Company. In this system, as will be seen by reference to Fig. 1, one side of each subscriber's line is grounded at the switchboard and all switching processes are concerned with the second limb of the line only. The sleeve side of the jacks is used for the signal circuits only. The operation of the system is quite evident, the lamp signal circuits being controlled to give the usual signals of the common battery system by the opening of their circuits or by being shunted by the energizing of the various relays.

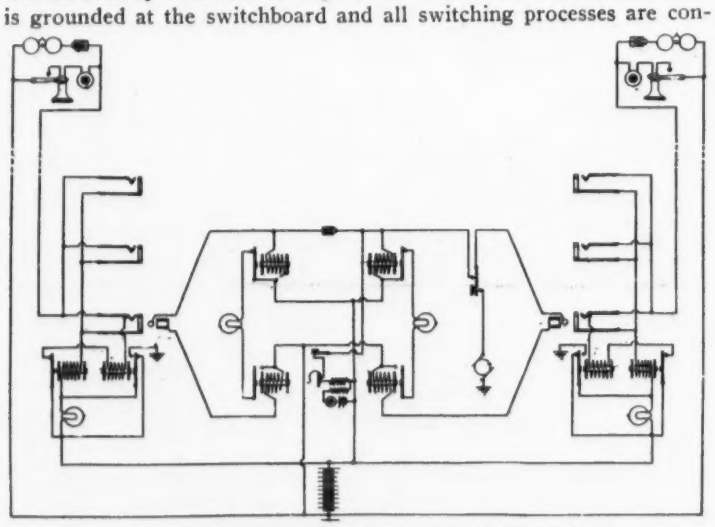


FIG. 1.—ROBERTS COMMON BATTERY SYSTEM.

A short time since a patent appeared for a trunk circuit so arranged that it provided an automatic busy test. This same principle has now been extended to local switchboard connections and Mr. J. L. McQuarrie, of Chicago, has obtained a patent for such a system. Mr. McQuarrie's system provides the usual line relay, but the cut-off relay is so arranged that while normally a considerable portion of its resistance is shunted, when a line is in use and the cut-off relay is, therefore, energized, the shunt is removed and the whole resistance of the wiring in circuit. It is this difference of effective resistance of the cut-off relay which permits the devices to distinguish between a line in use and one not in use.

When an operator has answered a call in the usual manner and has discovered the desired connection, she at once completes the connection to the desired line without preliminary test. As her cord circuits are normally open, the calling subscriber is not connected through to the desired party until after certain relays have operated. These relays fail if the full resistance of the cut-off relay of the desired line be in circuit, this being the condition when the desired line is in use. Under these conditions a humming sound is sent back to the calling subscriber. If the desired line be free and its cut-off relay circuit be therefore of low resistance, the controlling relays will receive sufficient current and will operate and cut the circuits through. At the same time the station desired will be automatically rung, and then all these switching relays will become locked in position such that the connection will be maintained in the normal condition until the conversation is complete and the plugs returned to their sockets. The Western Electric Company has been assigned the patent for this system.

Another patent relating to circuit arrangement is one granted to F. R. McBerty, of Evanston, Ill., also assigned to the Western Electric Company. This patent relates to an arrangement whereby a meter connected to the circuits will register automatically each call made as soon as the desired party responds. The service meter is connected in the sleeve or third wire of the cord circuit, and its operating current is so great that it will not respond to the currents which flow in that circuit until a certain part of the resistance is shunted out. This shunting is only accomplished by the response of the desired party.

SUB-STATION CONDENSER.

Another patent, one granted to H. G. Addie, of Cresco, Iowa, describes an arrangement of condenser in a containing case for ready and simple connection into this receiver circuit. The containing case carries two binding posts and a two-strand cord. The cord taps one binding post and a condenser terminal, while the second condenser terminal is connected to the second binding post. The condenser may be inserted by the mere transfer of the receiver cord to the condenser binding posts, and the connecting of the condenser cord to those binding posts of the instrument just cleared.

LETTERS TO THE EDITORS.

German Patents on American Inventions.

To the Editors of Electrical World and Engineer:

SIRS:—One of those slanders, so common in political matters, has been floating through the air now and then, to the effect that the German Patent Office rejects applications for patents when filed by Americans. In my experience I have found it no more difficult to secure patents for inventors there than in the United States, nor more difficult for American inventors than for Germans. Furthermore, the courts uphold patents without regard to where the inventor resides. As an illustration, permit me to mention one that I know about personally, as I obtained the patent for the Mica Insulator Company, the applicants being three persons of the company, and residing in the United States—full-blooded Americans. The Supreme Court of Germany confirmed the validity of their German patent, 73,830, and pronounced a *German* corporation infringers.

NEW YORK. EDWARD P. THOMPSON.

Fogs and Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

SIRS:—The following application of wireless telegraphy to the protection of ships in a fog has occurred to me, and it may possibly find valuable use through publication in your paper: Two ships are approaching each other, their presence being mutually known through wireless communication. Let one of the ships discharge a gun and dispatch a wireless impulse at the same moment. The differ-

ence in time of reception of the two effects by the other ship considered together with the rate of transmission of sound will be a measure of the intervening distance. Again, if one of the ships remains motionless while the other moves at a rate and in a direction by the compass, which may be easily communicated to the standing ship, several observations of the distance between them made at intervals in the above manner will serve to definitely locate the two boats with reference to each other. In a somewhat similar manner a base line may be established upon a dangerous coast terminated at either end with a cannon or bell. During a fog a wireless impulse simultaneously with the discharge of a gun at one end of the established base, may be followed at a definite interval by a similar commotion at the other station. A ship observing these effects could easily locate her position with reference to the base line, and since the latter would appear upon the charts, dangerous localities could be avoided.

Another application to the exploration of unknown localities on land would be accomplished by sending on the wireless receiving apparatus, to positions where it was desired to know the longitude. The moment of passage of the sun past the meridian at a known location could then be announced by a message transmitted to the unknown position, and the difference in time between reception of the message and the arrival of the sun would indicate the distance.

NEW YORK. GEORGE H. MORSE.

DIGEST OF CURRENT ELECTRICAL LITERATURE

DYNAMOS, MOTORS AND TRANSFORMERS.

Interphase Connections on Two-Phase Generators.—A note on interphase connections on two-phase generators securing low voltages for starting induction motors. It has recently been suggested that a scale of starting voltages may be obtained from two single-phase transformers by simply connecting the secondaries together at points to one side of the middle point of the winding. In a few instances this principle has been applied to the windings of the generator armature. The windings are connected together at the one-third point which gives the various voltages as seen in Fig. 1. A fifth collector

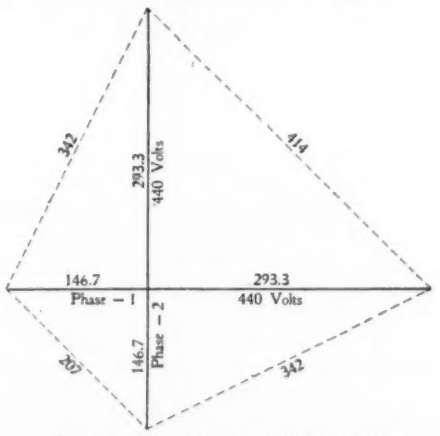


FIG. 1.—DIAGRAM OF CONNECTIONS.

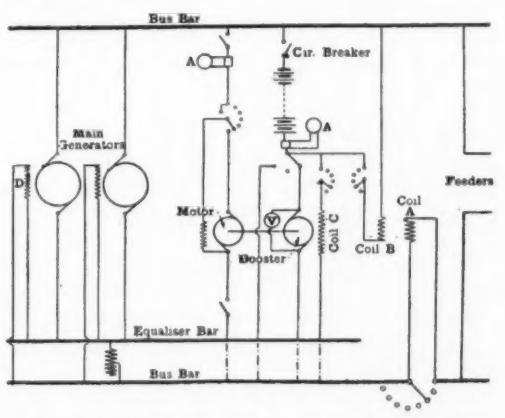


FIG. 2.—DIAGRAM OF TRAIN LIGHTING SYSTEM.

ring is connected with this common point, which at once provides a two-phase voltage series of 146.7, 293.3 and 440, the latter being the full voltage of the generator. In machines of low voltage, parallel circuits in each phase winding are necessary. In order to make this interphase connection in all the parallel circuits a copper ring is placed on each end of the armature, each ring joining the one-third points of all the parallel windings of one phase, and the two rings joined together by a connector passing through the framework of the armature.—*Elec. Club Jour.*, December.

Repairing Pitted Commutators.—A note on repairs of pitted commutators. When a pit is discovered, the hole should be cleaned out thoroughly with a sharp steel instrument, taking care that the carbonized mica is cut out entirely, and also that the projecting points on the copper between the bars caused by the arcing are smoothed off. The hole should then be filled with mica if a large one, or a mixture of plaster of paris and shellac if a small one. If the pit is carefully cleaned, this will prevent any further pitting at that point. —*Elec. Club Jour.*, December.

REFERENCES.

Induction Motors.—KARAPETOFF.—A very full illustrated discussion of the theory and application of the Heyland diagram.—*Elec. Club Jour.*, December.

Synchronizing.—An elementary exposition, illustrated by diagrams, of the method of synchronizing alternating-current machines.—*Elec. Club Jour.*, December.

LIGHTS AND LIGHTING.

Train Lighting.—REYVAL.—A very long and fully illustrated description of the Aichele process of train lighting used by the Brown-Boveri Company. Each car has its own generator, storage battery and regulator, all being placed outside, so that the interior of the car contains only the lamps and the necessary conductors. The regulator disconnects the dynamo from the circuit when the speed of the train becomes lower than is necessary for producing the required e.m.f., the regulator again connects the dynamo to the circuit instead of the battery when a minimum speed of 15 miles per hour is reached; the regulator finally limits the strength of the current for charging the storage battery when it is approaching full charge. The regulator is an entirely electromagnetic device and is described in detail. A trial with the system is made on a car of the Swiss railways. The battery consists of 18 cells of a total capacity of 90 to 100 amp.-hours for 100 candles, the duration of the discharge being 10 hours. Experience has shown that the largest variation of voltage at the terminals of the lamps was not more than ± 0.4 volt, and with the new regulation is reduced to ± 0.3 volt. The current strength, which had shown maximum variations of ± 0.5 amp., is now showing variations of not more than $\pm$ 2.5 amp.—*L'Eclairage Elec.*, December 17.

POWER.

Power Distribution in South Wales.—A long illustrated article on the works of the South Wales Electric Power Distribution Company. The connections will very soon amount to 9,000 hp. By far the greater part of this load is for actual power supply, the lighting load being chiefly confined to one small town. For the purposes of supply, the area is divided into four parts, each with its own generating station. The power house at Treforest is the largest, and three-phase currents are generated there at 11,000 volts, with a frequency of 25 per second. At Cwmbran the same pressure and frequency has been adopted for the larger feeders, but 2,200 volts has been deemed sufficient for the works nearer the station. At Bridgend the pressure is 3,000 volts, two-phase, at 60 periods, and at Neath 2,200 volts, two-phase, 50 periods. The higher frequency in the latter two stations was adopted partly because they supply alternating current for lighting to the local authorities and partly because the Bridgend station had to be started as early as possible, and the two-phase, 60-period plant was available from the manufacturer's stock. The power house at Treforest is the largest, and being in the center of the South Wales colliery district, a large load is anticipated both for driving the plant

in and about coal mines for a large number of miscellaneous works in their neighborhood. At present the main electrical supply at the Treforest station is from two three-phase alternators, each of 2,500 kilovolt-amp. There are also two 240-kw, direct-current sets for driving the auxiliaries in the station and the 300-kw, three-phase set for taking the light load or for supplying at a lower pressure (2,200 volts) to consumers comparatively near the works. The Cwmbran station is at present equipped only with 300-kw units. Up to the present practically all of the sub-stations on the system are fitted with stationary transformers, since two-phase or three-phase currents are employed at nearly all the works. The chief exception is that of a large iron and steel plant, where direct current has been preferred. For this purpose a motor-generator sub-station is being erected. An application, apparently new for England, of electric power at these works, is the Wellman furnace charger used for charging open-hearth furnaces. This machine has four motors, each driven by a separate series motor and controlled by a separate controller. At present the largest motor on the mains of the distribution system is a 400-hp induction motor, which runs off the 2,000-volt, 25-period, three-phase supply from the Cymbran station. This motor drives two sets of rolls at a wire-drawing mill. For starting, a water resistance is inserted in the rotor circuit. Some smaller motors of 20 and 8 hp are in use at the same works; they have short-circuited rotors and are started by means of an auto-transformer.—Lond. *Elec.*, December 2, 9.

Generation of Power.—Emmott.—His presidential address to the Leeds Section of the British Institution of Electrical Engineers. He gives a brief retrospective review of the development of electrical engineering and then discusses especially the question of power generation. He believes that at no distant date a combination of power gas generator and gas engine will perform a very important function in our generating stations. From tests he has made with a suction gas producer of 250 B.hp he has no hesitation in concluding that an average over-all thermal efficiency of 25 per cent., or twice that of a good steam plant, can be obtained. A comparison of "the relative sizes of the steam and gas engine is in favor of the former, so far as floor space is concerned. The question of speed is also in favor of steam, so far as the size and cost in the dynamo are concerned. The relative first cost of the two classes of engine is also in favor of steam; at the same time the cost of the power gas plant is less than boilers, etc., and the cost of banked-up fires for steam to meet any emergency (which is no inconsiderable item in the generating costs of a large station) does not exist. With a supply of gas at hand we have no difficulty in starting up and getting current on to the switchboard in slightly under a minute. For small stations, say to meet their requirements up to 15,000 inhabitants, a gas-driven plant will prove to be a most successful combination in the very near future." There has been a marked increase in Great Britain in the number of combined refuse destructor and electricity works which have been put down of late and all indications go to prove that the number of such works will increase even more rapidly in the near future. A refuse destructor has become in many places an absolute necessity on sanitary grounds alone. Some use must be made of the steam generated, and the production of electricity seems to be the most natural way. The author states that there is now no difficulty in getting "an output of 45 kw per ton of refuse" of even only a fair average quality, so that the return is worthy of consideration.—Lond. *Elec.*, November 25.

Electric Power at Cotton Works.—An illustrated article on the electric power distribution plant at an Irish cotton works. Water power is utilized to drive a three-phase generator of 60 kilovolt-amp., running at 750 r.p.m. and generating current at 1,100 volts and 50 periods per second. Power is transmitted to the works, 1½ miles distant, by means of bare overhead copper conductors. At the works there are three oil-cooled transformers which reduce the voltage to 200. Chiefly on account of the very low load factor obtained in bleach and print works, the application of the electric drive has shown particularly satisfactory results. So low, indeed, is the load factor that prior to the introduction of electric driving it was found economical to drive all the largest machines, such as Callender and Stenter fans, etc., with separate steam engines, each with its long and wasteful line of steam piping and consequent large steam consumption.—Lond. *Elec.*, December 16.

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Riva.—An article on the new hydro-electric installation in Tyrol, with power transmission to Riva, a little town, and some places in the neighborhood. There are four three-phase generators, one of 300 hp and the other three each of 150 hp; the voltage generated is 3,460 and the frequency 50. The high-tension current is transformed to low-tension, alternating current in the places of consumption.—*L'Eclairage Elec.*, December 10.

Water Turbines.—Dalemont.—An illustrated note on the wear and tear of water turbines of different constructions.—*L'Eclairage Elec.*, December 17.

Traction.

Automatic Reversible Booster.—An illustrated description of the Crompton-McIntosh automatic reversible booster. Fig. 2 shows the arrangement of a tramway station where it is desired to make the bus-bar volts rise and fall in proportion to the load. This is obtained by the equalizer bar and the series coil, *D*, which are connected up as shown, so that the battery current as well as the generator current flows through the series winding of the generator. In most stations, however, it is desired to keep the voltage constant, say at 5,000 volts, and in this case the equalizer bar and the series coil, *D*, are omitted, and the motor and booster connections are prolonged to the bus-bar, as indicated by the chain-dotted lines. The following detailed description refers to the latter case: The motor, which is directly coupled to the booster, is shunt-excited and the field of the booster is excited by the coil, *C* (in which a current flows proportional to the difference of generator volts and battery volts), and the differential winding, *A* and *B*. When the battery volts are equal to the bus-bar volts, there is no current in coil *C*, and it has no effect. When, however, the battery voltage is lower than the bus-bar pressure, a current flows in coil *C* in one direction; and when the battery voltage is higher, in the other direction, so that for every volt the battery falls, the booster voltage rises by one volt, and vice versa. In order that any considerable current may pass out of or into the battery, it is necessary to provide further excitation to compensate for the armature reaction. The differential coils, *A* and *B*, accomplish this: coil *A* carries the whole (or a definite adjusted proportion) of the feeder current; coil *B* is a shunt coil across the battery which opposes *A*. When it is desired to run the station on the battery alone, without the assistance of a generator, coil *B* is cut out. This coil may be varied in strength by a rheostat, according to the size or number of the generators which are running. The operation of switching the battery and booster on to the line is as follows: The three-way switch is put on the middle stud, and the battery circuit-breaker closed. The battery will probably stand at quite a different voltage from the bus-bars; the booster (which is on open circuit) is then run up and the coils, *A* and *B*, are cut out, coil *C* being left in. The booster will then be found to give a voltage exactly equal to the difference between the battery and the bars, and the three-way switch may, therefore, be thrown on to the booster stud, completing the battery circuit without a spark. Finally, coils *A* and *B* are put in, and the operation is complete.—Lond. *Elec.*, December 9.

1,400-*Volt, Three-Wire Traction System.*—An illustrated article on the electric railway between Bechyne, Bohemia, and Tabor. The line is 16 miles long and at present eight trains are run every day. Local conditions required the generating plant to be located near the Tabor terminal, over 16 miles from Bechyne. Direct-current distribution at 750 volts was not considered advisable, as the heavy drop in voltage would have required the installation of a costly storage battery equipment at some point along the line. Alternating current was rejected, owing to higher first cost, lower efficiency on light load and less availability in using it for a combined railway and lighting plant. It was decided to install a three-wire, 1,400-volt, direct-current system, with 700 volts on each side and the rails as neutral. As half of the motor equipment operates on one side of the circuit and half on the other side, the system is well balanced and very little current flows through the neutral. The advantages over the use of a straight 1,400-volt line are that under no circumstances, even in case of short-circuit, can a motor be exposed to more than 700 volts and no difficulty has been experienced in commutator or motor insulation with this pressure. In fact, the results have proven so satisfactory that the manufacturers proposed the construction of a line operating at 3,000 volts and using 800-hp locomotives. Each double-truck motor car is provided with four 30-hp, 700-volt motors.—*St. R'y Jour.*, December 10.

REFERENCES.

Interurban Line.—An illustrated article on standards of construction on the Indianapolis Northern line of the Indiana Union Trac-

tion Company, representing the latest construction methods of this company. The various standards of overhead and track construction, bridges, culverts and transmission lines are illustrated and described. All power is generated at the central station at Anderson. The older portions of the system are supplied by high-tension transmission lines operating at 15,000 volts. The new portion is supplied over three-phase transmission lines operating at 30,000 volts.—*St. R'y Jour.*, December 17.

London Metropolitan Railway.—The first part of an illustrated description of the Metropolitan Railway, which, after having been operated for nearly 42 years with steam, has now been electrified. The beginning of the electric operation took place recently. The power house when completed will contain four turbo-generators, of which two are now running. The history of the undertaking is outlined in a long editorial, with special reference to the long discussion of three-phase versus direct-current on this line. The system used is the ordinary direct-current system at 500 or 600 volts, with high-tension, three-phase generation and distribution to sub-stations.—Lond. *Elec.*, December 16.

Green Bay.—An illustrated article on the electric railways centering at Green Bay, Wis. They are about to be consolidated, which will result in a number of improvements of construction and operation. A new power station has been built from which power is transmitted at 16,000 volts to a converter sub-station. The power station itself also contains rotary converters for supplying the nearby line.—*St. R'y Jour.*, December 10.

New Jersey.—An illustrated description of division terminal improvements in New Jersey, which have been made by the Public Service Corporation, and which embrace an excellent treatment of the repair shop problem. A description is also given of the new sub-stiation for the operation of the Montclair division.—*St. R'y Jour.*, December 10.

Brake.—MATTERSDORFF.—A description of a new electromagnetic brake of such a construction that on grades of considerable length the brake coils are not heated too much; weight, space and price are stated to be low.—*Elek. Bahnen.*, No. 23, December.

Brakes.—DEWSON.—In a continuation of his serial on electric railway braking the author discusses details of the straight air brake. —*Elec. Club Jour.*, December.

Electric Automobiles.—LACAU.—An article on details of the pneumatic and mechanical arrangements of electric automobiles. He favors chain driving.—*L'Eclairage Elec.*, December 10.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Paris.—With respect to the question, What is to be done by the city when the licenses of the companies furnishing electric light and power at present in Paris expire, the Department of Public Works of the City of Paris has asked for the opinion and advice of the following firms and gentlemen: Siemens-Schuckert Company, Berlin; Brown-Boveri Company, Baden, Switzerland; Allgemeine Elektri itäts Gesellschaft, Berlin; Prof. E. Gerard, and Prof. S. P. Thomson. Three answers have so far been received. E. Gerard advocates the generation of high-tension, alternating currents, with transmission to sub-stations, but is not outspoken in his choice of secondary distribution. If the main load is for lighting, he is in favor of converting the high-tension, three-phase currents into direct current in sub-stations provided with storage batteries. For the outlying districts, however, he prefers transformation to low-tension, alternating current in small transformer stations. He further says that the more energy is used in the distribution network for power purposes, the less important become the reasons which are in favor of conversion into direct current. The Siemens-Schuckert Company considers it rational to establish one or two steam-driven central stations of a total capacity of about 80,000 hp, with steam engines or steam turbines driving three-phase alternators of 5,000 to 10,000 hp, the voltage being 8,000 to 10,000. For the secondary distribution system two solutions are possible. The first is to transmit the 10,000-volt, three-phase currents by underground cables to numerous transformer stations where the high-tension, alternating current is transformed to low-tension, alternating current for transmission on a four-wire system, the tension between the phases being 210 volts and the tension between the neutral wire and the three-phases being 120 volts, the former voltage being suitable for motors, the latter for lighting. The second method is to transmit the 10,000-volt, three-phase currents to a certain number of sub-stations for conversion into direct current. The company favors the latter system with distribution by the three-wire system at 2 × 220 volts. The Allgemeine Elektricitäts Gesellschaft gives a very long opinion, covering nearly 13 full pages of the journal. The opinion is based on the comparison with the results obtained by the Berlin Electricity Works. They believe that Paris will finally need one or more central stations of a total capacity of about 300,000 hp, but 100,000 hp is considered as the limit suitable for one station. The company is in favor of the generation of 12,000-volt, three-phase currents for transmission to sub-stations, but unlike the Siemens-Schuckert Company, the Allgemeine Elektricitäts Gesellschaft, considers three-phase, low-tension current distribution as the most favorable system for secondary distribution. For each central station it is proposed to install two steam turbines of 10,000 hp each and five of 20,000 hp each. The statement discusses at great length various details of the installation.—*L'Industrie Elek.*, December 10.

REFERENCES.

Starting Switches.—The conclusion of the very long illustrated serial giving notes on various types of motor-starting switches, which has been running for considerable time in the columns of this journal.—Lond. *Elec. Eng.*, December 9.

Switchboards.—PECK.—An illustrated article on modern practice in switchboard design. The author deals with the general arrangement, the materials used in the construction and with switchboard instruments.—*Elec. Club Jour.*, December.

WIRES, WIRING AND CONDUITS.

Insulation for Wires.—At the recent exposition of the Berlin Electrical Society, the Allgemeine Elektricitäts Gesellschaft exhibited wires covered with a kind of enamel and which can stand high temperatures, such as 400° C. or more, and are able to be bent without the enamel cracking off. The layer of enamel is very thin and a coil of such enamel-insulated wire takes considerably less space than cotton-covered wire. A substitute for silk-covered wire is "so-called acetate wire with a cover of cellulose-tetra-acetate."—*Elek. Anz.*, December 11.

ELECTRO-PHYSICS AND MAGNETISM.

Variation of Magnetic Hysteresis with Frequency.—LYLE.—An abstract of a British Physical Society paper giving an account of experiments made on two rings of laminated annealed iron, in one of which the radial breadth of the iron was considerable relative to its mean radius. These rings were magnetized by alternating currents of different strengths and periods; both the magnetizing-current wave and the magnetic-flux wave were quantitatively determined by a wave-tracer, and the wave forms so obtained subjected to harmonic analysis. The experiments were divided into series in which the period and wave form of the magnetizing current were kept as nearly constant as possible throughout any one series, while its strength was varied. The analytic expressions for the associated current and flux waves for a few series are given in tabular form. From the analytic expressions for each pair of associated waves it was found that when the magnetizing current was approximately sinusoidal, the total iron loss, I, was, within certain limits of the induction, given by a formula, $I = (a + b\,n)\,B^{1.67}$, where n is the number of periods per second, B the "effective induction," and a and b are constants. When from the total iron loss per c.c. per cycle the sum of the statical hysteresis and the value that theory assigns to eddy-current loss was subtracted, a considerable quantity remained, which increased both when the frequency and the flux density increased. This quantity, called by Fleming the kinetic hysteresis, has been obtained for each experiment. An interesting case of transformation and what is called reflection of energy is drawn attention to and discussed. If the e.m.f. impressed on the magnetizing circuit on the iron ring be sinusoidal, the flux wave produced contains third, fifth, etc., harmonics. These higher flux harmonics induce currents in the magnetizing circuit, which are dissipated as heat in it. Thus we have a tranformation of electrical energy due to alternating currents of frequency, n, to energy of currents whose frequencies are $3n$, $5n$, etc., which is reflected back into the magnetizing circuit. This the author believes is a hitherto unnoticed source of transformer loss. In the discussion Fleming, Campbell and Morris participated.—Lond. *Elec.*, November 25.

Absorption of Radium Emanation by the Human Body.—ELSTER AND GEITEL.—An account of experiments in which they tested Ashworth's contention that air breathed out of human lungs has a conductivity due to ionization. Ashworth attributed the bad insulation

of electroscopes in the lecture room to such ionization due to the breath of the audience. The authors have found on measuring the ionization of the human breath that it contains no proportion of ions above the normal proportion in the atmosphere. They conclude that there was an unknown source of error in Ashworth's experiments. They then proceeded to test the breath of a man who spends several hours daily in a room where radium preparations are made. This was F. Giesel, the well-known radium physicist. He was asked to blow air into the apparatus, some 18 hours after he had left his laboratory. The result was a degree of ionization distinctly above the normal. Giesel was himself a radioactive body, the substance having permeated all his tissues. The authors now propose to test whether a similar radioactivity is imparted to the human body by the consumption of water holding radium in solution.—Lond. *Elec.*, November 25; from *Phys. Zeit.*, November 1.

Actinium.—DEBIERNE.—A paper in which the author protests against the independent name "emanium" given by Giesel to the active lanthanum prepared by the latter. He shows that this emanium resembles actinium in all its chemical and physical properties, the only difference lying in its mode of preparation, which yields it in association with lanthanum of thorium. It is distinguished from radium by the fact that its emanation easily issues from solid compounds, and its ionization is much greater than that produced by the rays of the original body. The actinium emanation decays to half value in four seconds. The rate of decay of "emanium" is not yet quoted, but it will probably be found to be about the same.—Lond. *Elec.*, November 25; from *Phys. Zeit.*, November 1.

REFERENCE.

Electrical Origin of Gravitation.—SUTHERLAND.—A highly theoretical paper in which, on the basis of the electronic theory, gravitation and the earth's magnetism are traced to the circulation of something—probably the ether—such circulation being maintained by the doublets consisting of the oppositely charged electrons.—*Phil. Mag.*, December.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Sensitive Pivoted Instruments.—A note on the exhibition of some apparatus of Paul. The construction of highly sensitive pivoted electrical instruments has been rendered difficult by the fact that delicate pivots will not admit of transporting without injury. A number of galvanometers were shown in which the design was based upon the use of a moving coil, supported on one pivot in a powerful and uniform magnetic field, and controlled by a spring. The adoption of one, in place of the usual two pivots, renders it feasible to raise the coil when the instrument is out of use, and thus secure the pivot from risk of injury. By taking advantage of this and the incidental reduction of pivot friction, a practical instrument has been made approaching in sensibility to that of a reflecting galvanometer. Some of the instruments exhibited gave a full scale reading of 100 divisions for 2 millivolts or for 60 micro-amperes. Combined with shunts and resistances, other forms gave direct-reading insulation measurements to 2,500 megohms, pressures to 500 volts and currents to 25 milli-amperes in the one apparatus.—Lond. *Elec.*, November 25.

A Fault-Localizing Bridge.—A note on a form of stretched wire bridge devised by Moore for localizing faults in mains by the Murray loop method. It is intended for use with a testing voltage of about 12 volts across the loop and a resistance of about 15 ohms. There is a stretched platinoid wire 1 meter in length, of about 1.5 ohm resistance, this being stretched on a meter scale. A contact-maker slides upon this wire. In conjunction with it there are 18 non-inductance coils, each of the same resistance as the stretched wire, and connected to selector switches in such a manner that there are always nine coils and the stretched wire between the terminals, and so that the stretched wire may be made to take up any position in the sequence of the coils. This arrangement allows the equivalent of a longer range of scale than with the ordinary stretched wire bridge, but it is not quite so simple or so cheap to construct.—Lond. *Elec.*, December 9.

REFERENCE.

Testing Alternators.—WORKMAN.—In a continuation of his illustrated serial on factory testing of electrical machinery he deals with the regulation test of alternators loaded on resistances, inductive or non-inductive.—*Elec. Club Jour.*, December.

TELEGRAPHY, TELEPHONY AND SIGNALS.

REFERENCES.

Telephone Cables.—SCHMIDT.—An illustrated article describing several methods of construction of telephone cables for the purpose of avoiding induction currents in the same.—*Zeit. f. Elek.* (Vienna), December 11.

Electric Signals.—VERAX.—An illustrated article on electric signal lighting on the Lancashire & Yorkshire Railway.—Lond. *Elec. Rev.*, December 2.

Block Signals.—RITTER.—The first part of an illustrated article on automatic block signals for electric railways, operated by a line current.—*Elek. Bahnen.*, No. 23, December.

MISCELLANEOUS.

Dispersing Fog by Electrostatic Means and the Production of High Voltages.—A long illustrated abstract of an English patent recently granted to Sir Oliver Lodge for fog-dispersing apparatus and especially for the construction of robust machinery for producing the high voltages required. The high-tension unidirectional current is produced by a combination of a battery or dynamo with a high-tension transformer and mercury rectifiers. If a continuous-current source is used, the current is given a pulsating character by a suitable mechanical or electrolytic interrupter. The rectifiers are so connected that both half waves of the alternating current from the transformer are used. This method of connection is similar to that employed for a like purpose by those who have experimented with the aluminum electrolytic valve. In an editorial note the question is asked what the cost is of a given installation and how much power is required to drive it. It is conceivable that the power required may be considerable. However, "the dissipation of a London fog would be worth the value of many thousands of kilowatt-hours to the city of London." One of the arrangements described by Lodge is shown in Fig. 3, where *a* is a battery in circuit with an intermitter, *b*, and the primary, *d*, of a large Ruhmkorff induction coil; a condenser, *c*, may be placed in parallel with the intermitter, *b*. The secondary, *e*, of the Ruhmkorff coil is connected through two series of high-potential rectifiers, *f g*, to the terminals, *k m*, of the insulated coatings of a pair of Leyden jars, whose outer coatings, *j l*, are in electrical connection. To the terminals, *k m*, are also attached the leads for discharging wires, *o p*, which are supported by insulators, *n*. A dynamo may be employed in place of the battery. The leads or discharging wires must be well insulated. The dischargers may be points, flames or other means whereby a free discharge can be obtained; parallel rows of barbed wire or of barbed-wire fencing or other metallic areas may be used, one of which may be insulated while the other is earthed, or both may be insulated and placed facing each other beyond sparking distance in the place where the discharge is wanted. When the apparatus is used for the removal of smoke or the like, it is preferable to insulate both discharges; when electrification of clouds is the object, one set of dischargers would usually be earthed, and the other set arranged so as to be discharged skywards by well-insulated conductors. In the operation of the apparatus the current generated in the battery or dynamo is interrupted by the intermitter and induces intermittent pulses of violently high potential in the secondary coil of the Ruhmkorff coil; these pulses are transmitted through the rectifiers, positive pulses through the series *f* and negative pulses through the series *g*, to the insulated coats of the two Leyden jars. The object of each series of rectifiers is to transmit a current easily in one direction and to strongly oppose a passage of current in the opposite direction; by this means the intermittent supply from the induction coil is enabled to maintain the jar or jars steadily charged. The higher the potential desired, the more numerous are the rectifiers required in each series, and it has been found that three in each series is a convenient number to use where it is required to keep up a practically continuous discharge, between the dischargers, at a potential of about a quarter of a million volts.—Lond. *Elec.*, December 16.

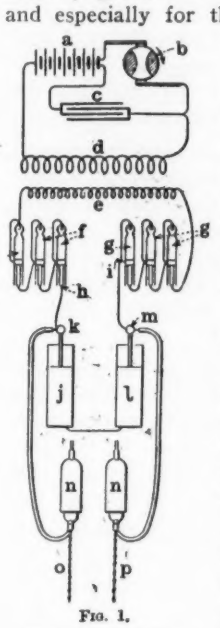


FIG. 3.—DISPERSING FOG.

FIG. 1.

Magnetic Separator.—An article on the Odling magnetic separator. The form adopted is that of electromagnets, as indicated by Tyndall in his researches on diamagnetism; instead of having blunt poles, the coils are fitted with masses of soft iron having a wedge-shaped section, so as to secure a strong magnetic field. By placing two wedges vertically, and having their sharpened edges horizontal

and close together, an intense magnetic field is created. The lower wedge is set slightly in advance of the upper. By having a thin inclined sheet of non-magnetic material between the ends and feeding upon it, the magnetic particles would at once leap to the upper magnet. Unless the upper magnet is moved, the action is soon brought to a standstill, owing to clogging. By putting scrapers in a certain amount might be cleaned off. The Odling device consists in placing a thin, endless, V-shaped rubber band over the slightly rounded edge of the upper wedge, and causing this to travel in one direction. The band, after leaving the magnet, passes over pulleys with V-shaped rims, and returns to the magnet again. The next problem was to make the particle, attached, pass the end of the wedge magnet; it was liable to travel to the end and stay there, so that clogging ensued. This is overcome by providing a peaked end, or a toe, for the wedge which projects beyond the lower pole; the intensity of the field is thus diminished and the weakly magnetic particles drop off. To remove the whole of the material, a sheathed iron disc is placed under this peaked end, having its axis parallel with the edge of the magnet. The particles follow in the revolving disc and fly on to it, but as they pass to the lower side of the disc they drop off; in this they are assisted by a water jet. The power required is about 1 hp for a machine having an average capacity of one ton per hour. For most ores comparatively coarse grains may be treated, but slime may also be handled successfully.—*Eng'ing & Mining Jour.*, December 8.

Exhibition of Berlin Electrical Society.—The conclusion of the summary of exhibits at the twenty-fifth anniversary of the Berlin Electrical Society. As the chief exhibit of the Allgemeine Elektricitäts Gesellschaft are mentioned a Heraeus mercury vapor lamp made from fused quartz for photographic purposes, quartz glass being extremely permeable for ultra-violet rays, and a small 7-hp turbo-dynamo running with a normal speed of 4,500 r.p.m. This machine is said to be interesting on account of its small dimensions and its smooth running; it was mounted in a very simple manner on a wooden framework. Mention is made of wires covered with a kind of enamel (see also the abstract under "Wires and Wiring"). Siemens & Halske exhibited an oscillograph, a type-printing telegraph with a speed of 2,000 signals per minute, a long-distance telephone cable with Pupin coils and a method of transmitting compass readings into the distance. Nothing is mentioned concerning the new Siemens vanadium lamp.—*Elek. Anz.*, December 11.

BOOK REVIEWS.

DIE ELEKTROLYTISCHE RAFFINATION DES KUPFERS. By Titus Ulke. Halle: William Knapp. 150 pages, 86 illustrations. Price, 8 marks.

This is a translation by V. Engehardt, of Ulke's well-known book, "Modern Electrolytic Copper Refining." The work has been well done and it should find a place in the library of the German metallurgist. Any English reader would, of course, buy the original.

KUNSTLICHER GRAPHIT. By Francis A. J. Fitz-Gerald. Halle: Wilhelm Knapp. 60 pages, 14 illustrations. Price, 3 marks.

This little book is especially to be recommended. The subject is attached in a careful, systematic manner. The many details are given with exactness. It should be a matter of pride to the American electrochemist that "Band XV" of these monographs of electrochemistry published by W. Knapp, is written by one of their number, and who has played a prominent part in the present development of the electric furnace. Nothing but words of praise can be applied to this work. Its title, "Artificial Graphite, Made in the Electric Furnace," sufficiently describes.

DIE DARSTELLUNG DES ZINKS. By Emil Gunther. Halle: Wilhelm Knapp. 243 pages, 59 illustrations. Price, 10 marks.

The two hundred and forty-three pages of the above volume describe with exactitude about fifty proposed processes for the electrolytic reduction of zinc. The method used in most cases is the leaching for the production of zinc chloride followed by electrolysis of the zinc chloride with the production of zinc and chlorine. Unfortunately but one of these processes has met with any commercial success, viz.: the Hoeppner process as used by Brunner, Mond. & Co., in England. However, any such compilation done in a spirit of faithful thoroughness cannot but prove beneficial to those attempting to solve the problem of applying electrical methods to treating low-grade zinc ores.

ELEKTROLYTISCHES VERFAHREN ZUR HERSTELLUNG PARABOLISCHER SPIEGEL. By Sherard Cowper-Coles. Halle: Wilhelm Knapp. 17 pages, 13 illustrations. Price, 1 mark.

The author of this little book has done us all (and we hope himself) a service, by putting in definite, convenient, get-at-able form his experience in making mirrors by electrolytic deposition. We recommend this book to those who would like to see a good example of what scientific knowledge, backed by mechanical ingenuity, can effect.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION. 1903. Washington: Government Printing Office. 876 pages. Illustrated.

This large but important annual volume contains much interesting material. From it we learn that the Smithsonian Institution disbursed nearly $180,000 as appropriated by Congress for the various purposes and duties coming within the scope of the Institution. Secretary Langley's report alludes to the unusual opacity of the atmosphere during the year 1902-1903. The sun's radiation energy was about 10 per cent. below the average throughout the visible and infra-red spectrum; and over 20 per cent. below the average, in the blue and violet. The temperature of the sun from the distribution of radiation in the solar spectrum is stated to have worked out 5,920° C. above absolute zero.

The bulk of the volume is found, however, in the General Appendix, which contains excerpts of papers on topics of leading scientific interest. These cover a wide range of subjects, including astronomy, physics, engineering, geodesy, botany, biology, zoology, anthropology, archæology and geography. The papers of special interest to electricians and electrical engineers are as follows:

"Modern Views of Matter," by Sir Oliver Lodge; "The Electric Furnace," by J. Wright; "High-Speed Electric Interurban Railways," by George H. Gibson; "The Marienfelde-Zossen High-Speed Electric Railway Trials," by D. Alfred Gradenwitz; "Terrestrial Magnetism in Its Relation to Geography," by Capt. E. W. Creck; "Robert Henry Thurston," by Prof. W. F. Durand.

The articles have been carefully selected and arranged, so that the volume contains therein the substance of the main advances in science during the year under review. A person who had been absent during this year from civilized countries might become acquainted, on receiving this volume, with the main discoveries and scientific advances during his year of absence.

LEÇONS SUR L'ELECTRICITÉ. Professés à l'Institut Electrotechnique Montefiore annexé à l'Université de Liége. Paris: Gauthier Villars. Par Eric Gerard, Directeur de cet Institut. Sixth edition. Vol. I, 818 pages and 388 figures; Vol. II, 791 pages and 387 figures.

The fact that this treatise, or series of "lessons," has reached a sixth edition bespeaks at once its intrinsic value and the appreciation of the class of students for whom it was written. The author was placed in 1883 at the head of the electrotechnical department of the University of Liége, where his classes consisted mainly of men seeking electrical instruction necessary for a professional training. Of theory they wanted all the fundamentals and somewhat more, so as to thoroughly understand the principles involved in the practice of the various branches of their profession, and at the same time to have the necessary knowledge to enable them to follow intelligently and with profit the discussion of technical matters in scientific papers, in which they would naturally become interested. Over and above this, they sought to acquire such a grasp of principles and familiarity with methods as to be able to apply them readily in the different industries to which they would be attached.

The present work was written to meet those diverse and extensive wants. Though Clerk Maxwell is kept well in view, his heavier mathematical machinery is advisedly omitted. The calculus is, however, introduced from the very beginning and a liberal use is made of it throughout. Vol. I opens with the general theory of potential, after which follows immediately its application to the electric and magnetic fields. The electric current forms part of the early chapters, its various modes of production, measurement and transmission being briefly but clearly explained. The experiments of Elihu Thomson on electromagnetic repulsion have not escaped the author's attention, but we search in vain for Rowland on the magnetic effect of electric convexion, Pupin on wave propagation in connection with telephonic transmission and Lodge on signaling through space. With few ex-

ceptions, the illustrations, which are very numerous, are excellent. Among the exceptions may be cited Kelvin's siphon recorder and Hughes's telegraph transmitter.

Vol. II is taken up almost entirely with generators, transformers, motors, storage batteries, etc., as well as with some of the Protean applications every day made of electricity for the benefit and comfort of man.

Prof. Gerard has no space for the *historique* of his subject; that indeed would be beside his purpose; but he does find space, and rightly so, to recommend works that have an important bearing on the matter treated in each chapter. These "Leçons" of Prof. Gerard form a comprehensive treatise in which the young electrical engineer as well as the electrotechnical student will find just the instruction in kind and extent that he needs, set forth in a manner that pleases by its clearness and precision.

Alternating Currents. Their Generation, Distribution and Utilization. By George T. Hanchett, New York: J. Wiley & Sons. 175 pages, 95 illustrations. Price, $1.00.

This little book should perform satisfactorily the task its author attempted—to explain as clearly and simply as possible the phenomena as well as the apparatus of alternating currents of electricity in their various practical phases. There is, however, some doubt if the hydraulic analogies employed in the first chapter are of real service in illustrating the phenomena of alternating currents. The lack of exact analogy will be apt to mislead those who are adepts in hydraulics, and to those not versed in that branch it would probably be easier to impart the alternating-current principles direct instead of setting the reader the extra task of becoming familiar with hydraulic principles in order to apply them to the understanding of electrical principles.

The treatment of the single-phase transformer is unusually complete for a book of this nature, and while the explanations are extremely simple, accuracy has not been sacrificed. As introductory to the study of polyphase currents there is included a chapter on phase difference and vector summation which leads to an easy treatment of two and three-phase circuits.

The chapter on the induction motor is written in a manner to appeal to the practical man, and except for minor inaccuracies introduced by reason of the attempt to simplify to a degree the discussion, the subject matter is well handled. The fact that the torque reaches a maximum at a certain slip is attributed wholly to the decrease of the core magnetism with increase of secondary current, while in reality the space displacement of the current in the secondary due to the local reactance of this coil is the most prominent reason why the torque does not continue to increase with increase of secondary current. On pages 119 and 120 it is stated, "When there is much leakage, the torque will be much reduced. By inserting resistance either in the rotor or stator windings, the magnetic leakage will be less and the torque will be greater," and on page 121 "The effect of putting resistance in the stator circuit is, of course, to operate the stator at a reduced voltage. The ambiguity is due to a lack of distinction between primary and secondary members."

The author is not very consistent in his use of the term "power factor." In some cases, notably on page 147, he agrees with other writers as to its significance, but there is much doubt as to his meaning on page 121, where he states, "An induction motor has a power factor due to the shift of the phase of the primary current by reason of the wattless component required for magnetizing purposes. This power factor is considerably larger than that which appears in transformers, and its larger value is due principally to magnetic leakage (reluctance?) which makes the necessary magnetizing current larger than otherwise would be the case. Hence, induction motors are built with exceedingly small clearance gaps." On page 174 he states, "The user can get better satisfaction out of an induction motor because it is less trouble, but the synchronous motor has a power factor which can be reduced to zero, or even arranged to compensate for the power factors of other devices on the line."

The chapters on the management of alternating-current generators and motors are well written and contain valuable suggestions for the operation of these machines. The book is of convenient size and shows the results of efforts to eliminate all extraneous matter. It will prove a valuable handbook for the practical engineer.

BOOKS RECEIVED.

Die Wechselstromtechnik. Vol. IV. Die Synchronen Wechselstrommaschinen. By E. Arnold and J. L. La Cour. Berlin: Julius Springer. 842 pages, 541 illustrations. Price,

Die Wechselstromtechnik, Vol. II. Die Transformatoren. By E. Arnold and J. L. La Cour. Berlin: Julius Springer. 369 pages, 335 illustrations. Price, 12 marks.

Die Wechselstromtechnik. Vol. III. Die Wicklungen der Wechselstrommaschinen. By E. Arnold. Berlin: Julius Springer. 366 pages, 426 illustrations. Price, 12 marks.

Handbuch der Elektrotechnik. Vol. VI. By Pohl and Soschinski. Leipzig: S. Hirzel. 448 pages, 395 illustrations. Price, 20 marks.

Entwurf und Konstruktion. By Ernst Schulz. Hannover: Gebruder Janecke. 132 pages, 110 illustrations.

Das Elektrische Bogenlicht. Vol. I. By W. B. von Czudnechowski. Leipzig: S. Hirzel. 98 pages, 14 illustrations. Price, 3 marks.

Die Asynchronen Drehstrommotoren. By Dr. Gustav Benischke. Braunschweig: Friedrich Vieweg & Son. 172 pages, 112 illustrations. Price, 5.50 marks.

Berechnung und Entwurf Elektrischer Maschinen, Apparate und Analgen. Vol. I. By Dr. F. Niethammer. Stuttgart: Ferdinand Enke. 576 pages, 472 illustrations. Price, 16 marks.

Theoretische Grundlagen der Starkstrom-Technik. By Charles Proteus Steinmetz. Braunschweig: Friedr. Vieweg & Son. 331 pages, 143 illustrations. Price, 9 marks.

Elektrotechnischer Fabriken. By Dr. F. Niethammer. Stuttgart: Ferdinand Enke. 364 pages, 378 illustrations. Price, 9 marks.

Der Kaskadenumformer. Band VI. By E. Arnold and J. L. La Cour. Stuttgart: Ferdinand Enke. 174 pages, 38 illustrations. Price, 2.40 marks.

Die Prufund von Gleichstrommaschinen. By C. Kinzbrunner. Berlin: Julius Springer. 390 pages, 249 illustrations. Price, 9 marks.

Controle des Installations Electriques. By A. Monmerque. Paris: Ch. Beranger. 775 pages, illustrated.

High Temperature Measurements. By Le Chatelier, Boudouard and Burgess. New York: John Wiley & Sons. 341 pages, 79 illustrations. Price, $3.00.

Einleitung in die Theoretische Elektrizitatslehre. By Dr. Ignaz Wallentin. Leipzig: B. G. Teubner. 444 pages, illustrated. Price, 12 marks.

Annual Report of the Smithsonian Institution. 1903. Washington: Government Printing Office. 876 pages, illustrated.

The Polytechnic Engineer. The Annual Organ of the Engineering Society of the Polytechnic Institute of Brooklyn. 156 pages, illustrated.

Etude sur les Resonances. By G. Chevrier. Paris: *L'Eclairage Electrique.* 76 pages, illustrated.

Die für Technik und Praxis Wichtigsten Physikalischen Grossen. By Olof Linders. 396 pages, 43 illustrations. Price, 10 marks.

Resistance, Inductance et Capacite. By J. Rodet. Paris: Gauthier-Villars. 257 pages, 76 illustrations. Price, 7 francs.

Kathoden und Röntgenstrahlen. By Dr. Friedrich Neesen. Leipzig: A. Hartleben. 240 pages, 50 illustrations. Price, 4 marks.

Elementare Vorlesungen über Telegraphie und Telephonie. By Dr. Richard Heilbrun. Berlin: Georg Siemens. 47 pages, illustrated.

Traite Theorique et Pratique D'Electricite. By H. Pecheux. Paris: Librarie Ch. Delagrave. 720 pages, 800 illustrations. Price, 17 francs.

Manuale Practico per L'Operaio Elettrotecnico. By G. Marchi. Milan: Ulrico Hoepli. 337 pages, 189 illustrations. Price, 2.50 lire.

The Dynamics of Particles and of Rigid, Elastic and Fluid Bodies. By A. G. Webster. Leipzig: B. G. Teubner. 588 pages, illustrated. Price, 14 marks.

Le Turbine a Vapore ed a Gas. By Giuseppe Belluzzo. Milan: Ulrico Hoepli. 413 pages, 300 illustrations. Price, 12 lire.

Electric Lighting. A Practical Exposition of the Art. By Francis B. Crocker, Ph.D. New York: D. Van Nostrand Company. 482 pages, 213 illustrations. Price, $3.00.

THE ELECTRICAL TRANSMISSION OF ENERGY. By A. V. Abbott, C.E. New York: D. Van Nostrand Company. 675 pages, ten folding diagrams and sixteen full-page engravings. Price, $5.00.

LIGHT ENERGY. By Margaret A. Cleaves, M.D. New York: Rebman Company. 827 pages, 55 illustrations. Price, $5.00.

TELEGRAPHIE UND TELEPHONIE OHNE DRAHT. By Otto Jentsch. Berlin: Julius Springer. 211 pages, 156 illustrations. Price, 5 marks.

DIE BERECHNUNG ELEKTRISCHER LEITUNGSNETZE. Vol. II. By J. Herzog and C. Feldmann. Berlin: Julius Springer. 451 pages, 215 illustrations. Price, 12 marks.

Electrical Industry in 1904 and 1905.

The most accurate idea as to the conditions and prospects of an industry is that which can be obtained from the field, and from concerns whose apparatus or service is offered to the public. We are therefore glad to be able to give below a number of statements from companies and indviduals engaged in all departments of electrical industry or in mechanical branches associated with electrical development. These statements, taken in conjunction with others appearing elsewhere in our commercial and industrial news, throw a flood of strong light on the situation. It will be seen that while there is general agreement as to partial depression during 1904, there is an equally strong and general impression as to the bright prospects for 1905.

C. J. TOERRING COMPANY, makers of arc lamps, Philadelphia, report that business on the whole in 1904 was quite satisfactory, and that the promise for the future is very bright. They have been encouraged by the demand to put on the market a number of new lamps.

CROSELMIRE & ACKOR COMPANY, the platinum firm, of Newark, N. J., say: "As to our present year, 1904, we are very well satisfied with the business which we have done and the prospects for the coming year show that it will be a great deal better. We have placed some very large contracts with some of the largest concerns in this country, but the part most interesting to your readers, who use material of this character, is that prices are high at the present time and will be a great deal higher. The raw material is very scarce, owing to the troubles existing at the present time in the Far East, together with the fact that Russia is entirely frozen up, so that the mines cannot be worked even if they had men to do this work. We look for much higher prices for next year."

SAMSON CORDAGE WORKS, Boston, Mass., write us: "The past year has been the largest for our 'Spot Cord' of any in our history, and from present prospects we think there will be a still further increase next year. We understand there is nothing new under the sun, and we thought we had finally got 'Spot Cord' about perfect, but we have made one or two improvements in the finishing and inspecting, so that it can be relied on even better than before. We trust we shall find next year as good for business as the present prospects would indicate."

HELIOS MANUFACTURING COMPANY, Bridesburg, Pa., makers of arc lamps, etc., reports, through Vice-President Frank S. Marr, that it has found business very good and is very hopeful of an even larger trade during 1905.

BISHOP GUTTA PERCHA COMPANY.—Mr. H. A. Reed, the veteran cable manufacturer, writes us as to growth: "We are putting a fourth story on our old three-story factory in New York, 75 by 90 feet. It will be used principally for gutta percha tissue. During the past year we have put up a new building 25 by 40 feet, four stories and basement, principally for storage, relieving the factory from all material, either raw or finished, except that in process. We have also doubled the area occupied by offices and laboratory. When the present improvements are completed, our capacity will be nearly double what it was two years ago, and the prospects for 1905 are that it will be fully employed."

AMERICAN ENGINE COMPANY.—Mr. Frank H. Ball, the general manager, writes us as follows: "In regard to the business situation and the prospect for the coming year, we are very glad to report that, although the year has been a very slack one, the last three months have given us more new business than we ever received in the corresponding period in previous years. We start off the new year with our books well filled with good orders."

SCRANTON BUTTON COMPANY, of Scranton, Pa., who make composition specialties, many of which are used in the telephone field, write us as follows: "We would say that we had, during 1904, a larger and much more satisfactory business than ever before, and look forward with confidence to an increased business in 1905.

ELECTRIC HEATING APPARATUS.—Mr. Jas. I. Ayer, manager of the Simplex Electric Heating Company, Cambridge, Mass., says: "We are very happy to state that the increase in electric heating business has exceeded our expectations and for the past few months has taxed our capacity to the utmost. We are, notwithstanding exceptionally well provided with facilities to care for our work. The outlook could not be better."

STANDARD UNDERGROUND CABLE COMPANY.—Mr. J. W. Marsh, vice-president, writes us: "I am pleased to say that the volume of business for the year 1904 has actually exceeded that of the year 1903 for my company. From all the indications that we have had thus far, I believe that the year 1905 is going to be a very prosperous one in the entire electrical industry."

DODGE & DAY, the modernizing engineers, of Nicetown, Pa., are in an exceptionally good position to note the trend of things. They say: "We have had a very prosperous year, regardless of the period of depression which prevailed along some lines prior to the Presidential election. Our relations in an engineering capacity with various manufacturers give us a clear insight into their business, past and prospective, owing to the character of our work, and we can, therefore, say with some degree of certainty, as a result of this knowledge, that prospects for the coming year are exceptionally bright. We have been called upon to make a number of layouts contemplating the expenditure of several million dollars, which is the best indication we know of that manufacturers are sanguine as to future conditions. We also know that the inquiries being received by our clients for quotations on their apparatus are larger at the present time than anything they have had for months past, and the feeling all along the line seems to be, after the holidays are over, and the annual readjustment of stocks is made, that there will be a marked increase in the demand for all lines of product."

MESSRS. A. C. LESLIE & COMPANY, of Montreal, agents for "Remy" brand of tungsten magnet steel, report a very satisfactory trade during the past year. There has been a marked increase in the use of this grade of steel for telephone apparatus. In the past, while the European telephone makers have almost invariably used tungsten steel for their magnets, American makers usually considered this a needless expense, but they are now finding that the increased power and permanence obtained more than compensate for the extra cost. The firm also mention that their principals in Europe have largely increased facilities for turning out finished magnets and are prepared to supply these of any design made from "Remy" steel, which has established such a favorable reputation for itself all over the world. The consumption of this grade of steel during the coming year is likely to increase and the price is also likely to be higher, owing to continued scarcity and very high price of tungsten.

H. W. JOHNS-MANVILLE COMPANY writes us as follows: "Our electrical business has never known a year of such general prosperity as 1904. The amount of material turned out from our factories has been far greater than in any previous year, and our entire product has been advantageously placed. Although there has not been a great deal of electric railway building throughout the country, and although the Presidential campaign might justly be calculated to have a depressing influence, our enclosed fuse output has developed to a wonderful extent, closely followed in proportion of increase by our line material. The outlook for the coming year in this country, particularly in railway work, bears greater promises of activity than any year within the past decade. British and European business also gives us much cause for self-congratulation. Our factories, although improvements and additions have been made constantly, are running at their utmost capacity to handle our orders. We believe that 1905 will be exceptionally prosperous in all branches of the electrical business, and feel from past experience, that we will have no fault to find with the share which may fall to our lot."

DIEHL MANUFACTURING COMPANY.—Mr. Burnett C. Kenyon, president of the Diehl Manufacturing Company, of Elizabethport, N. J., writes us: "With reference to the prospects for next year I would say that they are very bright in the line of motor and generator production. The fan motor industry, as you know, depends on the weather conditions very much, and as we are no weather prophets, we hardly know what the outcome in this line will be."

BLAKE SIGNAL MANUFACTURING COMPANY, Boston, Mass., Mr. E. J. Burke, president, say: "Our business in the specialty of insulated staples has grown enormously during the past six months, and gives every promise of continued growth for 1905. So far as the signal is concerned it is a very new thing and really only just now ready to go on the market. Hence, the present year's actual business amounts to little. The signal, however, has met with a ready realization among both electric and steam road men of its uses and possibilities. We already have a number of propositions out for different roads for their consideration, and there is every evidence that the business for the coming year will be very good. While we do not anticipate any very wonderful industrial boom during 1905 we are satisfied that there is going to be a good demand in our line during the coming year."

CENTRAL ELECTRIC COMPANY, Chicago.—President George A. McKinlock, of this company, who is a shrewd and experienced observer of electrical conditions, makes the following note on the situation: "With reference to this year's business, I may say that the results, as a whole, have been satisfactory. During the first half of the year the depression the general trade underwent, was felt by us. The revival in trade the latter part of the year balanced the dullness of the first half. I am looking for the year 1905 to be equal, if not better, than the year 1902, which was the banner year of our business."

STUART HOWLAND COMPANY, of Boston, G. M. Stuart, manager, reports as follows as to electrical supplies and specialties: "We have found trade very satisfactory since August 7, our sales having shown a considerable advance over any previous year. So far as we can look into the future, we should say that the coming year will be especially prosperous."

SMITH & HEMENWAY COMPANY, the well-known cutlery and hardware firm, of New York City, through President Landon P. Smith, express these interesting views: "We take a very optimistic view of the situation for 1905. The latter months of this year have been of such a speculative nature for the buying element for 1905, that we are preparing for a large increase in our business. The demand for a better class of electrical tools of all descriptions seems to be increasing rapidly with the mileage of electrical circuits throughout the United States, and in closing our year 1904, we have seen a very rapid increase in our business. We can only state that we are taxing our factory to the utmost to keep up with the demands for new and improved electrical tools, showing that the electrician is strictly up-to-date and is ready to discard all the antiquated tools that do not suit his demand, and reinvest in an up-to-date line of goods where the quality will remain long after the price is forgotten. I believe that we will see, in the coming year, the best business year that we will have passed through in the past ten, and we are getting ready to take care of any increase that may come our way."

D. M. STEWARD MANUFACTORY, Chattanooga, Tenn., write as follows: "In the sale of our Lavite insulation, we deal direct with the manufacturers of all kinds of electrical apparatus in all parts of the United States and many foreign countries. When their business is good, ours is good, and when theirs is poor, ours is poor. Our business in 1904 show considerable increase over 1903. The months of September, October and November, 1904, are almost double the same months last year. We now have more unfilled orders on file than ever before at the same time of the year. We believe that 1905 will be a splendid year for electrical business, and are preparing to take care of an increased trade."

L. B. ALLEN & COMPANY, INC., the manufacturers of soldering pastes, sticks, etc., write us: "The outlook for our business for 1905 is a bright one. While the year 1903 was a record breaker in every branch of our industry, the year 1904 showed an actual increase of nearly 25 per cent. We attribute no small part of this to our ELECTRICAL WORLD AND ENGINEER advertising campaign."

THE JAMES LEFFEL & COMPANY, turbine builders, of Springfield, Ohio, consider the outlook for business during the coming year to be very good.

MARINETTE GAS ENGINE COMPANY, Chicago Heights, Ill., say: "The business outlook for 1905 is very gratifying and we anticipate a very prosperous year, particularly in connection with electrical power equipment."

STERLING ELECTRIC COMPANY, the manufacturers of telephone apparatus at Lafayette, Ind., write us: "The present year's business has been all that we have looked for. While in point of volume it has not been as large as the year 1903, yet it has been a very satisfactory year. The outlook for 1905 is very promising. New money is coming into the independent field, properties are getting upon a better basis, and our securities are being recognized by investors throughout the country. This is having the effect of opening up new territory, both as to exchange and toll lines; 1905 should be the banner year in the history of independent telephony."

W. N. MATTHEWS & BRO., St. Louis, Mo., agents, etc., for many leading electrical specialties, say: "Replying to your inquiry for our opinion of trade conditions for 1904 and 5, would say we feel that our little business is a splendid barometer as applied to outside construction, because Stombaugh guy anchors are only used in that connection. The fact that it was so hard to finance electric railroad and all other like propositions during 1904, naturally curtailed the orders for line material. In the past thirty days there has been such an astonishing increase in the demand for guy anchors, both for immediate and for future delivery, and so many new specifications covering them have come to us that we cannot but feel that there will be unusual activity in the building of electric lines of every description during 1905."

THE CINCINNATI TOOL COMPANY, Cincinnati, Ohio, says: "Business in the last six or eight months had not held up, but we have every prospect for the best trade this spring that we have ever had, and we are confidently preparing for it."

IMPERIAL PORCELAIN WORKS.—Mr. B. B. Dinsmore, of the Imperial Porcelain Works, Trenton, N. J., says: "As regards the business for 1904, we would say that it has been disappointing, but the present outlook for 1905 seems to be brighter."

NATIONAL ACME MANUFACTURING COMPANY, the manufacturers of automatic screw machines, etc., at Cleveland, Ohio, say: "Regarding trade conditions, we can only state what seems to be the general feeling throughout the trade, viz., that the volume of business is steadily increasing, with very good prospects for the coming year."

THE CUTTER COMPANY.—Mr. A. Edward Newton, president of the Cutter Company, Philadelphia, writes us as follows: "As to my views as to the current year's business, I can truthfully say what I think very few of my competitors can, that our circuit breaker business has been quite as large in volume as the previous year. Our export business has very largely increased. This was owing to our having won in a very important competitive test that was made in London last spring, which resulted in quite a big bunch of profitable business. The outlook for 1905 could hardly be better. The large hotel and office building industry has fallen off somewhat, but in lieu of this we have a constantly increasing demand from the progressive manufacturer."

LINCOLN ELECTRIC COMPANY.—Mr. J. C. Lincoln, president of this Cleveland concern, says: "We are moving into new quarters and shall have double the amount of space enjoyed previously. We have taken the ground floor of the Sigler Building, Lake and Wood Streets, which will give us the opportunity to double our business. We have been very busy all the past year, and the outlook for 1905 is bright."

AUTOMATIC TELEPHONY.—The Automatic Electric Company, Chicago, has enjoyed a most prosperous and satisfactory year and says: "We have equipped within the past twelve months nearly fifty exchanges—large and small—with our automatic telephone equipment. We have built and installed additional apparatus for large exchanges at Chicago, Ill., at Dayton and St. Marys, Ohio, which were put in service in 1903; we have completed and put in service exchanges at Grand Rapids, Mich.; Portland, Maine; Columbus, Georgia, and Cleburne, Texas, all of which were begun late in 1903. We have installed and placed in service this year exchanges at Battle Creek and Pentwater, Mich.; Lewiston, Maine; Lincoln, Neb.; Van Wert, Ohio, and Hopkinsville, Ky. We have in process of construction or installation exchanges for Los Angeles, San Diego and Riverside, Cal.; Wilmington, Delaware; Auburn, N. Y.; Columbus, Ohio; Sioux City, Iowa; Auburn, Maine, and Clayton, Mo. We are also installing additional equipment at Grand Rapids, Lewiston, Pentwater and Lincoln. We have had a splendid year, and are looking forward to a still better one. For 1905 we have about a million dollars worth of orders on hand. We are running our plant full capacity, and are working overtime on pending orders. The sentiment of the public and the operating companies is overwhelmingly in favor of automatic telephone service wherever it has been installed. We firmly believe that the day of universal automatic telephone service is not far off. It is coming as surely as the trolley car supplanted the horse car. It is the ideal telephone service. It is the system that appeals to all; to the user because of its promptness, its secrecy, its accuracy; to the operating company because of its economy of operation and maintenance; to the investor because it places the securities of a telephone company on a firm basis, keeps them stable and profitable."

YALE & TOWNE MANUFACTURING COMPANY, New York City, report as follows: "We have recently perfected our new electric hoist in 10 and 15 ton sizes. The unqualified succes which has this year attended the introduction of our new electric hoist, leads us to comment in accordance with your suggestion. We have had, as pioneers in the field of electric traveling cranes, many years experience in suiting the requirements of power hoisting equipments. The hearty endorsement of the engineering fraternity has been accorded these hoists since their introduction at the St. Louis Exposition, and the sales for the past few months have been second only to those of our well-known duplex, triplex and differential chain blocks. Present indications point to a very substantial increase in our sale of hoists for the year 1905."

WOODWARD GOVERNOR COMPANY, Rockford, Ill., say: "The year just closing has been the most prosperous in our history, the increase in sales being about 30 per cent. over that of 1903, which year also showed a corresponding increase over any previous year. The indications for business for the year 1905 are already very encouraging, and we look for as large an increase, if not larger, this coming year."

WATERTOWN ENGINE COMPANY, of Watertown, N. Y., Mr. S. T. Bagg, secretary says: "The past year in some respects has been most unusual. There is seldom a year when we have had so large an amount of prospective business, while at the same time little or nothing, relatively, has been closed. Business has been spasmodic and fluctuating during the year. We now have a very large list of possible orders on our salesmen's lists, and we feel very hopeful that January will bring us a more active trade than we have had for the past twelve months."

INDEPENDENT TELEPHONY.—Mr. Henry Shafer, president of the International Telephone Manufacturing Company, Chicago, expresses the opinion that independent telephony had a greater development in 1904 along substantial lines than during any previous year. He says: "The rush for unoccupied territory by newly organized companies has not been as great as in some years of the business, but the companies in the field have more thoroughly covered their respective territories and in a much more efficient manner. They have greatly increased their ties with one another by building necessary through trunk lines and long distance toll lines, which has had a tendency to place the general business upon a much sounder basis. The independent operating companies have also, the past year, generally adopted the very highest class of equipment, built along the most simple and approved lines, rather than the cheaper grade or experimental systems. This has inspired the manufacturers to develop the apparatus to the highest point of perfection and modernity to which money and skill can advance it. This has placed the independent manufacturers of the United States in a position where they are fully protected in the home market, as well as taking the lead in foreign countries. The 'Monroe Doctrine' has been successfully enforced in the telephone field by the 'International' during the past year, and we are making a substantial headway in getting into the Old World and through the 'open door.' In our opinion, the independent manufacturers of high grade, practicable and durable systems will have, this coming year, a far greater demand than at any time in the past."

BELL TELEPHONE DEVELOPMENT.—Mr. J. P. Davis, chief engineer of the American Telephone & Telegraph Company, Boston, writes us: "In connection with the growth of the business, I would say that the increase for the past year will probably be represented by more than 260,000 stations, and that there is every prospect of this number being exceeded during 1905." Mr. McCann, of the New York Telephone Company, enlarges on the situation as follows: "In 1894 the number of telephones in service in Manhattan and the Bronx was a little less than 12,000. In 1899, five years later, the total number was 39,500, an increase of over 200 per cent. From 1899 up to the present time the growth of business has been ever on the increase. In 1900 the number of telephones in service in Manhattan and the Bronx had increased to over 53,000. Two years later, in this same territory, over 96,000 telephones were in use, and the telephone company starts the year of 1905 with something like 152,000 telephones under contract and in service in Manhattan and the Bronx. Estimating the total population of the two boroughs of Manhattan and the Bronx at 2,500,000, the number of inhabitants per telephone is 16. A comparison of the telephone development of this district with the telephone development in the British and German empires and France, although in a sense hardly fair, as we are comparing in each instance a limited thickly settled prosperous district to a whole country, serves to emphasize nevertheless the extreme telephone development in these two boroughs. At the beginning of 1904 the telephones throughout Great Britain and Ireland numbered 312,714. This district had a population of over forty-one millions. At this same time the boroughs of Manhattan and the Bronx, with a population of less than two and one-half millions, had over 132,000 telephones in service and under contract, or, in other words, Great Britain and Ireland, with a population sixteen times greater than Manhattan and the Bronx, had considerably less than three times as many telephones. In the German empire, with a population of over fifty-six millions, there were at that time about 399,000 telephones, the population being twenty-two times greater than that of Manhattan and the Bronx, and the telephone development only about three times as great. In France, with a population of about 39,000,000, the telephone development only reached 108,875, the population in this instance being fifteen times greater than in Manhattan and the Bronx and the telephone development about 25,000 below that shown in this metropolitan section. From these comparisons an idea can be gained of the extent to which the telephone business has grown in this city. Two interesting features of this development in New York City are the growth of the private branch exchanges and the so-called pay station service. Private branch exchange service consists of a switchboard located on the subscriber's premises and connected to one of the company's exchanges by two or more lines. To this switchboard are connected as many telephones, either on or off the premises as are desired. By this means a splendid interior system is furnished, and at the same time each telephone is capable of immediate connection with any other telephone reached by wires of the local or long distance companies. This is very useful and is largely used in hotels and apartment houses, one New York hotel alone having 1,100 telephones. There are between five and six thousand of these private branch exchanges in New York City, aggregating over 60,000 telephones and ranging in size from the huge hotel systems to the small office equipment of two lines and two telephones. Another very important feature of telephone service in New York, as judged from the standpoint of the public, is the so-called pay station service, maintained by the company in certain public place, such as railroad stations, ferry houses, hotel lobbies, drug stores, etc. These pay stations are so numerous and well distributed over Manhattan Island that wherever one finds himself it is only necessary to take a few steps in order to reach a public telephone. It is needless to say that this service is of the utmost benefit to travelers and to the public at large."

RECENT WIRELESS WORK.—With regard to recent wireless telegraph work, the American De Forest Wireless Telegraph Company writes us as follows: "Some very remarkable distances have recently been covered by some of the De Forest wireless telegraph instalations. The operators at Buffalo and at Cleveland have read a large number of messages sent from the 2-kw station mounted upon the roof at 42 Broadway, New York City. This station is equipped with only a 100-ft. mast and this distance of 700 miles overland from a 2-kw station is considered very remarkable. From this same station messages have been read on board the Mallory line boats, 'Denver' and 'San Jacinto,' when less than 200 miles from Key West, Fla., or in the neighborhood of 900 miles from New York City. These two ships are each equipped with 1-kw apparatus, but they have been able to communicate over 350 miles. The De Forest Cape Hatteras station has in fact read messages from the 'Denver' when she was only 50 miles out from New York City. In the work from 42 Broadway to Buffalo and Cleveland it was noticed that signals were much more distinct at night than during the day. This is another evidence of the impairing effect on the transmission which the daylight exerts and which has only been noticed in one or two instances heretofore. In explanation of the extreme distances which have been attained from the 2-kw station at New York it is suggested that the location of this station, some 350 feet above earth on the top of a steel building plays an important part in this phenomenon. The source of electrical waves here is at an unprecedented height from the earth, and at the same time an excellent ground is afforded through the steel frame of the building."

THE DEMAND FOR POLES.—The Eccleston Lumber Company, of 29 Broadway, N. Y., in discussing the pole situation, say through Mr. J. B. Eccleston, president: "The largest consumers of poles have been experimenting considerably during the last two or three years, realizing that the supply of Northern cedar and chestnut poles is becoming scarcer and higher priced all the time. The result of their

experiments has been a frank acknowledgment that the Southern white cedar or juniper poles, are, in every way, as desirable as and more economical than the Northern cedar, principally from the fact that the butts of the Northern cedar poles are naturally more or less decayed. The common specifications allow 20 per cent. of butt rot, whereas the Southern cedar or juniper poles are perfectly sound, exceptionally straight, free from shakes and hold a good taper. The durability of the Southern poles is as good as the Northern poles, and their strength is equally as great. During the past year there has been over 400,000 of these Southern cedar or juniper poles used, which was all it was possible to get out in the swamps South, and at no time did the supply anywhere near equal the demand. It is the opinion of those best posted that this next year and the year to follow will see a tremendous quantity of Southern red cypress poles universally used, as the supply of cedar or juniper is very limited, and there is practically no limit to the amount of Cypress, that can and will be used for the purpose of poles. Present indications point to an exceedingly heavy demand for poles this coming year, and it would be well for the largest users to place their contracts at an early date, as they will, we believe, effect a very considerable saving, as the prices generally are bound to advance."

ELECTRICAL POWER DEVELOPMENT.—Abner Doble Company, San Francisco, discuss in an interesting way the year's developments in hydro-electric work, and say: "Our business in the water-wheel line and also in the electrical and allied branches which we represent as special agents, during 1904, has been very satisfactory. The volume has been even greater than we anticipated at the beginning of the year. The business has shown a substantial increase over the previous year and the outlook for the coming twelve months is very encouraging, as we look for marked improvement in all lines of electrical development. Our present works have been overtaxed, and in order to provide facilities for our growing business, we have purchased a three-acre site with railroad connections near the commercial center of San Francisco, where we plan to erect a most modern plant equipped with the latest tools and appliances for the manufacture and testing of everything in the hydraulic line. An interesting feature of the past year's business on the Pacific coast is the increase in size of hydro-electric units installed in water power plants. During the year the De Sabla power house has been completed, in which are installed two 3,700-hp and one 8,000-hp water-wheel units. The water wheels are of the Abner Doble Company's manufacture and operate under a head of 1,561 feet. The 8,000-hp water wheel is the largest ever manufactured on a single runner and is giving excellent service. We are now constructing three 8,000-hp water wheels for the Electra plant of the Standard Electric Company. Among other orders filled during the last year were two 800-hp and two 40-hp units for the Edison Electric Company, of Los Angeles, to operate under a 305 ft. head; two 75-hp units for the Pike's Peak Hydro-Electric Company, of Colorado Springs, for operation under a head of 2,100 feet, the highest in the United States; two 280-hp and two 50-hp units for the power plant of Cornell University, and a 260-hp two-wheel unit for the Hilo Electric Light Company, of Hilo, Hawaii Islands. The Cornell University units are being installed in the gorge at Ithaca, N. Y., and will operate under an effective head of 130 feet. This installation is especially interesting since tangential water wheels were selected instead of turbines for operation under the comparatively low head afforded."

NORTHERN ELECTRICAL MANUFACTURING COMPANY, of Madison, Wis., manufacturers of dynamo electric machinery and power transmission apparatus, express themselves as follows: "Relative to our opinion of the year's business, we are pleased to state that 1904 has been good to us; and the business secured was of a very satisfactory character. The volume exceeds that any previous year. Prospects for 1905 are excellent, although void of any boom indications."

TRIUMPH ELECTRIC COMPANY, of Cincinnati, Ohio, report, as manufacturers of dynamos and motors, that they believe business in 1904 was, as a general thing, in most lines, below the standard of previous years. Their sales of motors, however, for machine tool drive and work of that character surpassed that of any other year by something over 40 per cent. They regard this as a marked indication of the widespread adoption of the electric motor for individual drives, especially in machine tool work. In other words, it is found to be the ideal mode of power transmission. As for the outlook for 1905, they consider it exceptionally bright. They take this view, not only from the numerous inquiries received at the present time, but from what other manufacturers report. Hence, their belief that 1905 is going to be a very prosperous year.

Physicians' Electrically-Driven Air Pump.

Prompted by a succession of agravating experiences with all sorts of flimsy devices that persisted in breaking down just at the wrong time and being out of commission the greater part of the time, one of New York's prominent physicians recently sought the advice of a firm of electrical engineers which has made a specialty of developing designs of motor drives for various kinds of machinery and systems of electrical control, and as a result decided to have an original design made which would cover a compact and substantial four-cylinder air compressor driven by an electric motor which in turn should be controlled by an electric controller actuated by the rising and falling of the pressure in the air tank or storage chamber.

The following description and the accompanying cuts will give a general idea of the complete equipment as designed.

A ⅞-in. round forged machinery steel shaft divided into two pieces at its middle point carries a worm wheel at its center. The

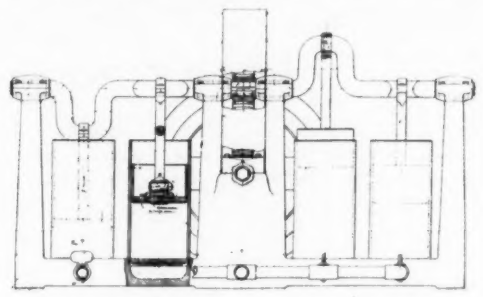


FIG. 1.—ELECTRICALLY-DRIVEN AIR PUMP.

two halves of the shaft meet in the center of the worm wheel hub and at that point are keyed together by a 3/16-in. square key.

As will be seen from the cuts, the shaft is forged so as to receive four connecting rods, two on each side of the worm. The bearing surfaces on the two halves of the crank shaft, that is, the four-crank shaft bearing surfaces, and the four connecting rod bearing surfaces, are all finished to a diameter of ¾ in. The shaft is also turned and fitted to the worm wheel hub and the two ends are machined to form the lap joint shown, which unites the two halves of the crank within the hub of the worm wheel

The pitch diameter of the worm wheel is 7½ in. and it has 47 teeth and a face of about 1⅛ in. wide. In order to afford protection to the

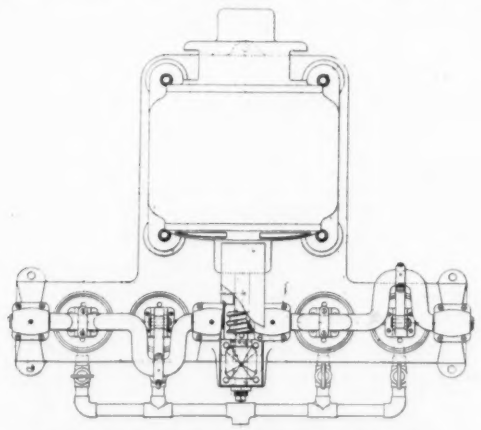


FIG. 2.—ELECTRICALLY-DRIVEN AIR PUMP.

operator and to insure against injury to the machine itself, this worm drive is encased in a sheet brass oil guard secured in place by small screws as shown.

The four cylinders and the four pistons are made of drawn brass tubing. Each cylinder feeds through a brass stop-cock into a common air pipe of ½ in. in diameter. This air pipe, which is provided with a suitable check valve, runs from compressor to the air tank.

The electric motor used for this device may be either for 110 or 220 volts and is standard in all particulars except that it has a special extended shaft on which a worm is placed.

The controller is a separate mechanism and is so constructed that a single-pole switch is thrown when the pressure in the storage tank reaches a minimum of five pounds per square inch. Likewise when the compressor has raised the pressure to thirty pounds per square inch the single-pole switch is thrown open. The pressure limits were

selected as being most suitable for the conditions under which this particular equipment was to operate, but any other pressure limits might be adopted if more suitable.

This substantial and practical equipment should prove useful to many doctors, dentists and others who have occasion to use air under pressure. The designs for this equipment were made by Messrs. Bates and Neilson, consulting engineers, of 42 Broadway, New York City.

"Inter-Pole" Variable Speed Motor.

A new motor has been placed on the market by the Electro-Dynamic Company, of Bayonne, N. J., known as the "Inter-Pole" motor. While it is essentially a variable-speed motor, it can also be used for constant-speed duty. It was designed especially to drive machine tools, pumps, blowers, wood-working machinery, laundry machinery and all other similar classes of machines, either direct or in groups. The motors operate on any two-wire, direct-current circuits from 110 to 500 volts, thus obviating the use of multiple-wire circuits.

The construction and arrangement of the motor enables brushes to be placed equi-distant between the poles, and the motor is capable of reversing its direction of rotation without detriment, and commutation in either direction of rotation takes place without sparking with either variable load or variable speed. Among the improvements in this motor are auxiliary field pole pieces, small as compared with the main pole pieces, and located between the latter. They are provided with coils connected in series with each other and in series

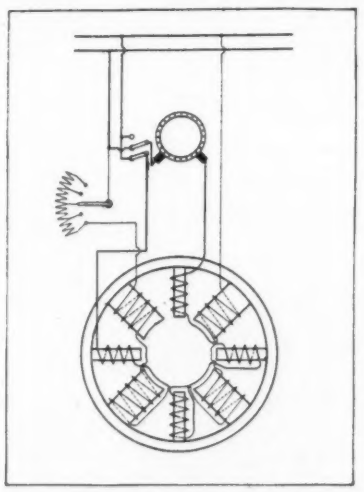


FIG. 1.—DIAGRAM OF MOTOR CONNECTIONS.

with the armature, and so proportioned and arranged as to give the proper field for commutation. Since the armature current flows through the coils, weakening of the field of commutation by an increased load is prevented, and the auxiliary poles produce the compensatory field of commutation independently of the main fields, which with increased number of revolutions of the armature must be correspondingly weakened. Moreover, the effect of the auxiliary poles is independent of the direction of rotation of the armature, because if the latter is reversed the current in the auxiliary field is also reversed.

The motor is equipped with ball bearings. The bearing consists of two races, one of which is fastened to the armature shaft and the other to the bearing housing, leaving, therefore, the stress of rotation directly on the balls. Between the balls is placed a spring separator.

The motors have been designed and constructed with the idea of reducing weight and the space to be occupied, and also for low speeds, so as to be more readily adaptable for direct driving of all classes and characters of machine tools and other classes of machinery. They have also been so designed that they can be placed in any operating position, even with shaft vertical and perform their functions in a perfect manner with no change being made in the machine. They are readily adapted to be used as open, semi-enclosed or enclosed motors.

The motors will have an average variation of 5 per cent. in speed from full load to no load at any set speed of the controller. This is a particularly important point to be considered in equipping machine tools with motors for variable-speed duty. Following is a résumé of the claims made for the new type of motor:

It gives constant speed for all loads at any controller position. The desired speed can be obtained by the movement of the little finger, instantly, by electrical not mechanical control. Any motor will run under full load equally well in either direction; in other words, is perfectly reversible under any load. The motor does not spark, but gives perfect commutation, under all loads. It is designed

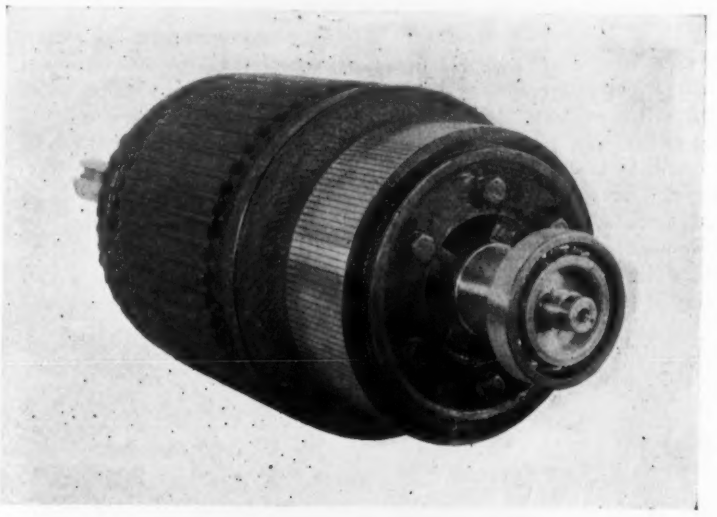


FIG. 2.—ARMATURE OF MOTOR.

especially to stand 100 per cent. overload without sparking. It embodies compactness in design, occupying the minimum of space, and low weight. Being equipped with ball bearings, the use of oil is obviated and a high efficiency obtained. It secures the highest pos-

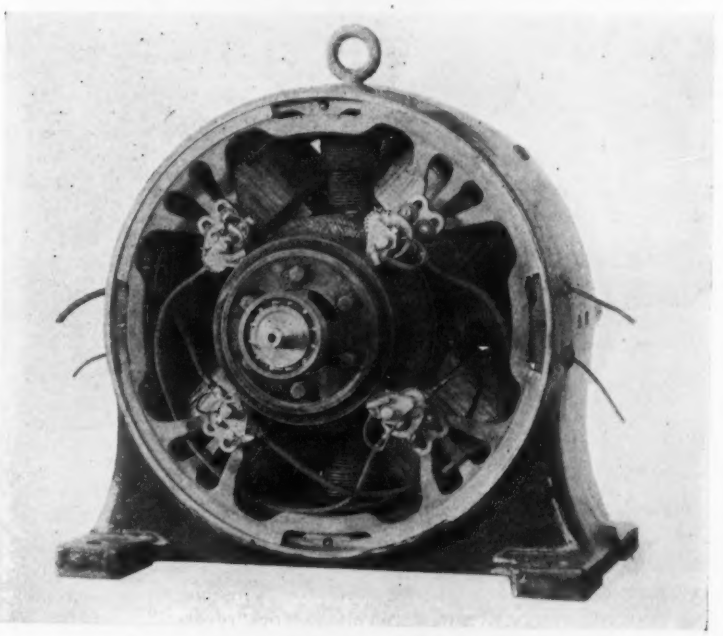


FIG. 3.—"INTER-POLE" MOTOR.

sible efficiency at all speeds, a minimum heating under all loads, and operates on a single-voltage circuit. It is made in enclosed, semi-enclosed and open types, and can be set in any position.

Rutland Electrical Workers.

An organization has been formed to be known as the Rutland Electrical Workers' Association, of Rutland, Vt. It is composed entirely of local people engaged in electrical work. A suite of rooms has been engaged in the Fenn Block, on Center Street. The following officers have been elected: President, J. G. German; vice-president, B. P. Carr; secretary, Herbert D. Cleaveland; treasurer, Austin Trudeau. Much time will be given to discussions of matters of interest to the members, and men prominent in electrical work will give addresses.

Special I-T-E Circuit-Breaker.

Aside from manufacturing its many lines of standard I-T-E circuit-breakers, the Cutter Company, as engineers, are designers of this type of apparatus for any special purpose that may arise. Some of these special designs we illustrate herewith.

Fig. 1 shows a single-pole "Auto-ite" circuit-breaker which cannot be closed or held closed during the continuance of overload on the circuit which it protects. This is attained by having the closing lever of the circuit-breaker engage with the toggle by means of a latch which is under control of the overload armature. Should an overload exist during the act of closing the circuit-breaker, the switch arm will instantly be released from the controlling lever and the circuit will be broken regardless of any pressure which may be brought to bear upon the handle. The disposition of both the closing and restraining latches is such that the automatic opening is not attended by movement on the part of the closing lever, the advantage of which is obvious where room in front of the switchboard is limited, and unexpected movement of the handle might bring it into forceful contact with the operator. While the circuit-

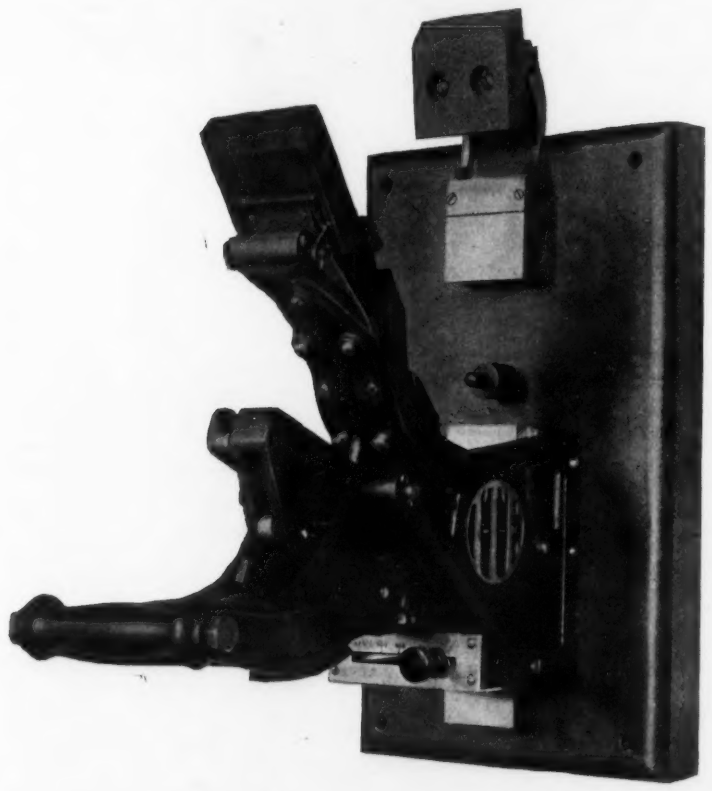


FIG. 1.—SINGLE-POLE CIRCUIT-BREAKER.

breaker is closed by a downward movement of the closing lever, it may be opened by a slight upward movement of the handle, responding in this case with the same quickness which characterizes its operation in the event of an overload. This circuit-breaker may also be made responsive to "no voltage" or "reversal" currents, or either of these in connection with overload operation.

Fig. 2 shows a three-pole "Auto-ite" circuit-breaker designed with especial reference to the requirements of three-phase lighting and power circuits, but which is equally adaptable to the protection of polyphase generators and motors or to use on three-wire, direct-current systems. Built on the "Auto-ite" principle, it cannot be closed or held closed on overload. During the automatic opening the closing lever remains stationary. The instrument opens with instantaneous break in response to a slight upward movement of the handle. The circuit-breaker illustrated is one of a number furnished to the British Westinghouse Company for the latest installation of the London County Council.

Fig. 3 illustrates a 2,000-amp. overload and reverse current circuit-breaker, which is one of a pair used for the protection of two 125-volt generators operating in multiple. As the circuit-breakers were mounted directly upon the generator frames, lugs were provided for making the connections upon the face of the apparatus. The conditions of operation were such that it was desired to have the circuit-breaker sensitive to a reverse current of 15 amp. or three-fourths of one per cent. of its rated capacity. This degree of refinement cannot be attained by any of the usual forms of construction involving the use of iron electrically magnetized, because the current required to operate on reversal is only a fraction of that

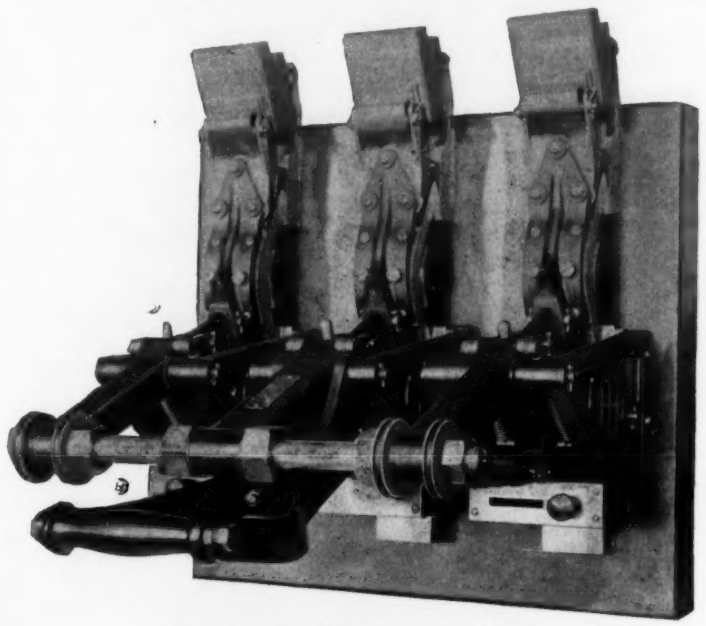


FIG. 2.—THREE-POLE CIRCUIT-BREAKER.

necessary to overcome the residual magnetism due to the normal flow of current.

The desired sensitiveness is secured, however, by making use of the reactions between a copper loop carrying the main current and a pair of highly magnetized permanent magnets, whose poles embrace the conducting members of the loop. These magnets are

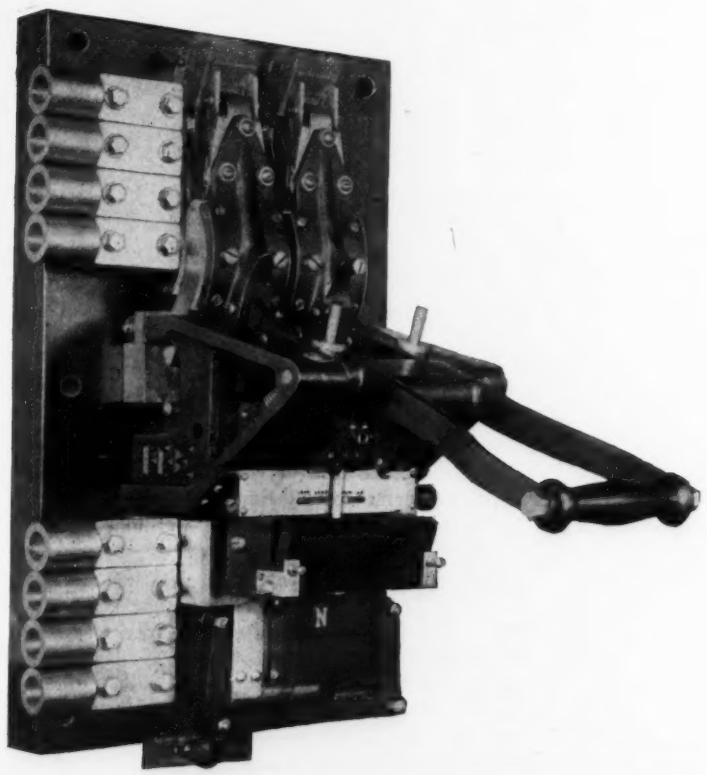


FIG. 3.—OVERLOAD AND REVERSE-CURRENT CIRCUIT-BREAKER.

mounted on a pair of supporting arms in such a way as to be capable of a slight movement in a horizontal direction; the magnetic system being slightly counterbalanced, tends to remain against a fixed stop. Current flowing in the normal direction holds it in this position and also tends to increase the magnetism of the system. Current in the reverse direction causes movement away from the stop into contact with a small clip, which closes the circuit of a

high-resistance shunt tripping coil. The adjustment of the reverse-current feature is secured by the movement of a counter-balancing weight along a calibration scale. The instruments illustrated have a range of adjustment of 15 to 140 amp. It was shown in test, however, that they could be made sensitive to 2 amp. or 1/10 of 1 per cent. of the rated capacity of the circuit-breakers.

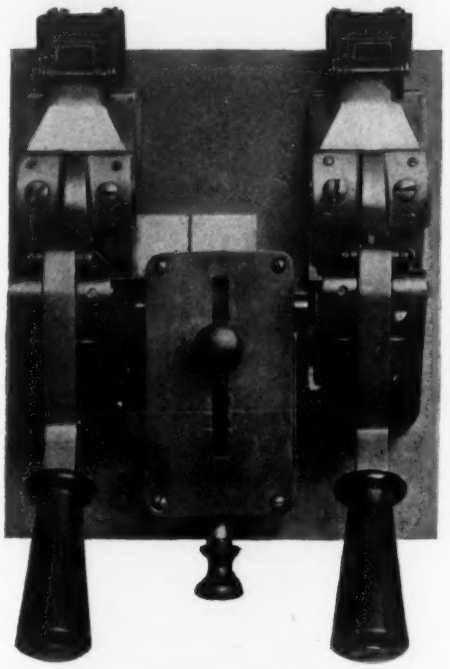


FIG. 4.—COMBINED CIRCUIT-BREAKER AND HAND SWITCH.

Fig. 4 illustrates a special form of "Dublarm" type, designed to be used as a combined circuit-breaker and handswitch. The photograph was made from one instrument of a lot of 150 which were installed upon the switchboard of the Metropolitan Life Building, New York City, by the Western Electric Company, to meet the special requirements of the consulting engineer, Mr. C. O. Mailloux.

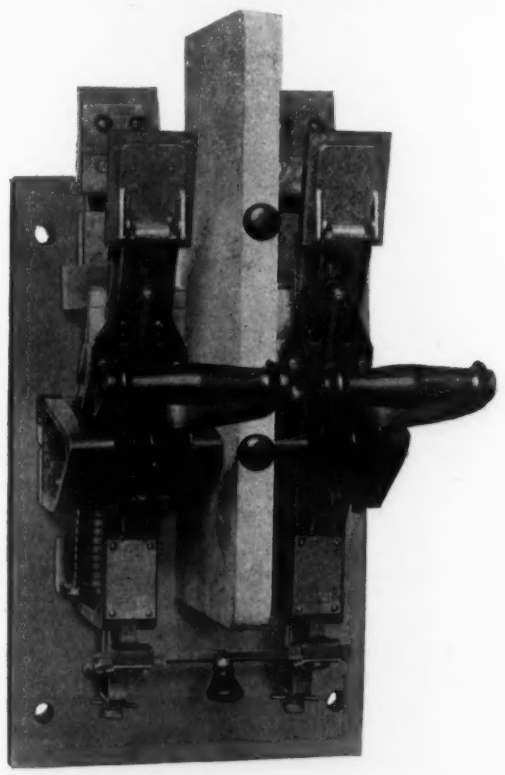


FIG. 5.—SPECIAL FORM OF CIRCUIT-BREAKER.

Fig. 5 shows another special form of "Dublarm" circuit-breaker, designed to meet the requirements of Burnham & Co., of Chicago, architects and engineers for the new Wanamaker store, New York City, which installation is being installed under the care of Mr. H. D. Babbitt, chief electrical engineer of the Thompson-Starrett Co.

Duncan Wattmeters.

Like every other branch in the electrical industry, the integrating meter has been the subject of many marked improvements during the past year. The principal features involved in the recent developments have been along the lines of increasing the driving torque and, incidentally, the retardation, so that the accuracy on very small loads could be depended upon to a degree not attainable heretofore. Another important change recently accomplished is one of design, whereby the bearings may be readily inspected and renewal of spindle points and jewels made with the greatest possible ease, without having to use special tools. The most recent type of Duncan direct-

FIG. 1.—DIRECT-CURRENT METER.

current wattmeter embodies, to a marked degree, the foregoing improvements, together with others equally up-to-date.

Fig. 1 shows the Duncan direct-current meter with its cover in position. This cover is removable from the front, thereby permitting the meter to be installed quite close to the ceiling. It also fits closely into a felt-lined groove and is absolutely dust and insect-proof. Fig. 2 shows the meter with cover removed, while Fig. 3 is a side view or elevation.

The series field coils are machine wound. The armature is wound

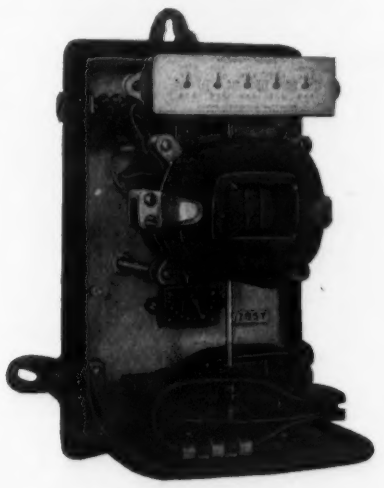


FIG. 2.—METER MECHANISM.

with 10,000 turns of No. 41 magnet wire and herein lies the meter's superiority, its torque being from 20 to 25 per cent. higher than other types, and it consumes less energy.

The retarding magnets are put through an artificial ageing process requiring six months and by the time they are put into the meter they are fully guaranteed to be proof against becoming weak, even in the presence of strong external fields. The retarding disc is made from the purest aluminum obtainable and is accurately weighed and balanced before being assembled.

An improvement in the construction of meters of great importance to central station managers is the "visual" bearing and "threadless" jewel post arrangement of the Duncan meter. With this the detach-

able spindle point may be taken out and inserted again without the slightest inconvenience. No special tools are necessary and the older clumsy and often awkward methods of renewing pivots are completely and successfully changed. The "threadless" jewel post, as the name implies, is bereft of threads and is held firmly in position by a wire spring. Its insertion or removal requires but a moment and no trouble is experienced from the stripping or binding of threads.

To prevent successfully the brushes from getting out of alignment, they are mounted upon a suitable moulded lava support and, being firmly secured thereto, their tension upon the commutator is also maintained constant.

The Duncan Electric Company has made numerous experiments during the past two years in producing an alloy to mitigate the commutator troubles to which direct-current motormeters have been subject ever since their adoption. The composition adopted prevents tarnishing and the commutators do not turn black after being in service for a short time.

The Duncan meter employs a compensating coil rigidly and securely fixed within the front series field coil and in close proximity to the armature. Its supplemental torque effect upon the armature is varied by cutting in or out of circuit a portion or portions of the turns comprising it. The terminals of the various groups of turns or windings of the coil are connected to corresponding contacts of a "multipoint" switch having a small lever or arm which makes connection with any of the contacts and bringing into circuit any number of turns desirable. To compensate for friction, the lever of the

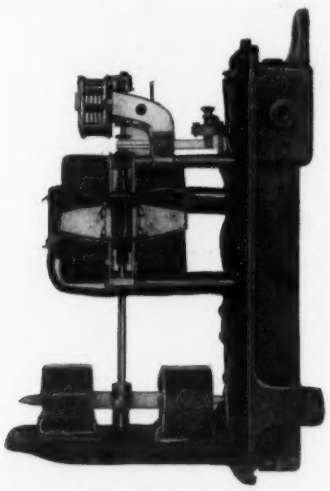


FIG. 3.—SIDE ELEVATION OF METER.

"multipoint" switch is moved toward *F*, thereby cutting in turns of the compensating coil; and to compensate for creeping the lever is moved toward *S*, thus cutting turns out from the coil. These changes require but an instant and are absolutely permanent. The range is exceptionally great and with its switch arm set for any given turns or compensation, it may be absolutely depended upon for permanency.

On account of many meters, equipped with wooden block supports for their binding posts, giving trouble by setting fire to these blocks when poor or loose connections are made, the binding posts in the Duncan meter are made fire-proof. No wood or other combustible material is employed, but instead a specially prepared insulating fibre that is chemically treated with tungstate of sodium.

The appearance of the meter is particularly pleasing since its finish is that of a semi-dull hard rubber black with the name plate silvered. The dials, which are extremely large, are made of porcelain, require no constants and read direct in kilowatt-hours.

General Electric Equipment for El Oro Mines.

The Esperanza Mining Company, largely controlled by British capital and one of the largest mining enterprises in Mexico, has awarded a contract to the General Electric interests for about 3,000 hp of equipment to be installed at its mines located in the famous El Oro camp. As previously mentioned in these columns, the Mexican Light & Power Company will transmit electric energy from its huge Necaxa plant for consumption at El Oro. It is estimated that at least 15,000 hp will be utilized in that mining district.

160,000-Volt Testing Transformer.

BY J. J. FRANK.

Two 50-kw, 160,000-volt transformers have been built by the General Electric Company for testing the insulators used on the transmission line of the Columbia Improvement Company. The external appearance of this transformer is shown in Fig. 1. It is of the core type, the windings being placed on the two vertical

FIG. 1.—160,000-VOLT TRANSFORMER.

legs. The low-tension coils are placed next to the core and consist of four coils supported on porcelain bases fastened to the bottom core clamp. The high-tension winding consists of 40 coils each separately wound and each divided into two separate sections. This sub-division of the high-voltage winding gives a maximum of 4,000 volts per coil with not more than 200 volts between adjacent layers. The insulation between the two windings is provided by the oil which flows through a duct sub-divided by cylindrical diaphragms of molded insulation into a number of separate channels. This construction, by providing several enveloping layers of oil, gives an insulating barrier, between the primary and secondary, which is comparatively thin but possesses exceedingly high dielectric strength.

To insure safe transportation and installation, and to prevent accident to the operator by contact with any part of a tank that could become charged by static induction, the tank is made of wrought

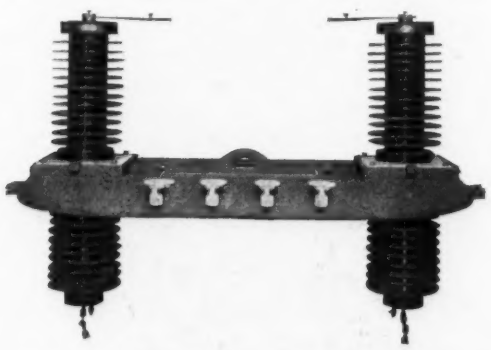


FIG. 2.—OIL-SEALED TERMINALS FOR TRANSFORMER.

iron with riveted and calked joints and riveted to a cast-iron base. The cover is of cast iron secured to the tank by two large bolts and may be readily removed together with the high-potential terminals.

The low-potential terminals are of heavy insulated cables brought through porcelain bushings passing through the cover. The bushings for the high-potential terminals are of a novel and most satisfactory construction, each consisting of a cylinder filled with oil through the center of which passes a copper terminal rod. These bushings, shown in the accompanying illustration, Fig. 2, are made of short sleeves or sections of molded insulation between which are placed discs of the same material, the whole being bolted together into an oil-tight structure and treated with "compound." The terminals thus formed are each fastened in a square marble base 1½ in.

thick, and the two are supported on a cast-iron bracket bolted fast to the cover. The upper portion of the terminal extends for a sufficient distance above the cover to prevent discharge from the terminal to the cover through the air, and the series of discs provide sufficient length of insulation to prevent any leakage to the cover. The

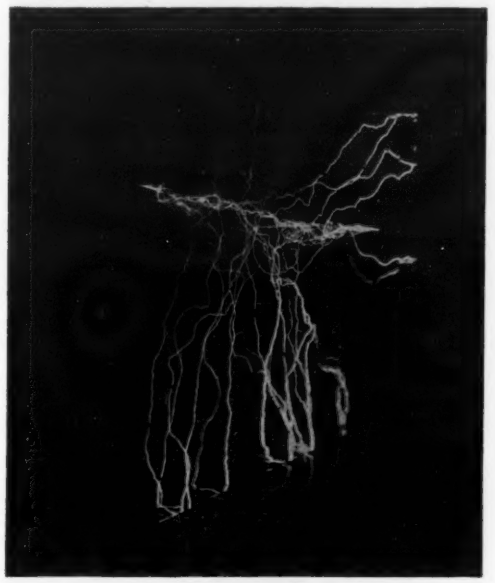


FIG. 3.—325,000-VOLT DISCHARGE.

lower portion of the terminal reaches below the surface of the oil in the transformer.

The above construction allows the terminals to be readily removed from the cover for safety in transportation or installation, or allows the cover to be removed with the terminals in place.

While the full potential of this transformer is 160,000 volts, additional terminals, beneath the surface of the oil in the tank, are provided whereby the full rated capacity of the transformer may be

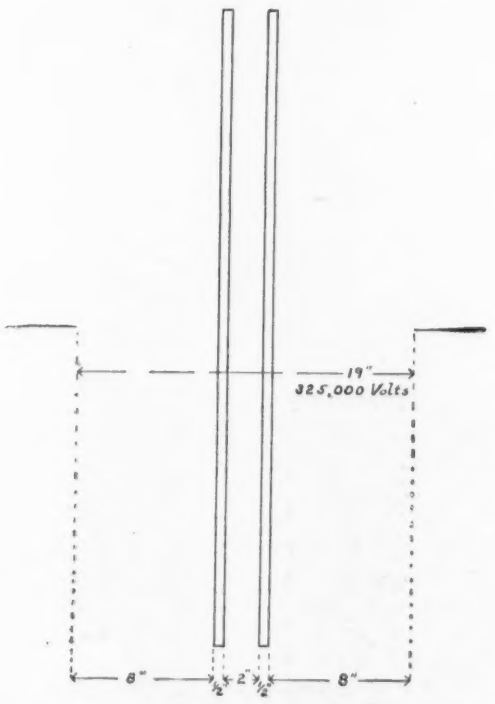


FIG. 4.—ARRANGEMENT FOR 325,000-VOLT DISCHARGE.

used at either 40,000 or 80,000 volts. These terminals are similar in construction to the main terminals just described.

Fig. 3 shows the discharge for one wave peak of such a high-voltage transformer, between points 19 in. apart and separated by a glass barrier, as shown in the sketch, Fig. 4. The photograph, of which Fig. 3 is a reproduction, was made with an exposure of 1/90 of a second, the number of alternations being 60 per second. It will be noted that the transparency of the glass plates renders the discharge visible throughout their whole length from one electrode around the bottom and rear edges of the barriers to the other electrode. Most of the discharges during the period of exposure passed around the bottom edges of the glass plates, where the latter rested on a horizontal plate of ebonite; the lines of contact with the polished surface of the ebonite being indicated by the faint reflections of these discharges.

Such high-potential transformers are used not only for systematic testing of insulators, but for testing the effective insulation of transmission lines to ground. A General Electric Company transformer built along the same general lines, adapted to give 100,000 volts, has been used by the Hudson River Water Power Company in testing its 33,000-volt transmission line from Spiers Falls to Schenectady.

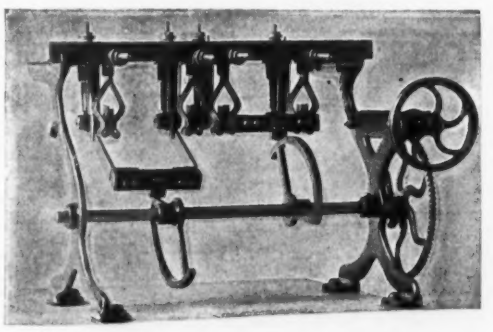
Following are some data abstracted from a report detailing tests that were made on this transformer: Exciting current, 0.86 amp., or 3.8 per cent. of total; energy current, 0.72 amp., or 3.2 per cent. of total; core loss, 1,600 watts; total loss at full load, 2,500 watts; regulation at 100 per cent. power factor, 2.2 per cent.; efficiencies, 1¼ full load, 95.3 per cent.; full load, 95.2 per cent.; ¾ load, 94.6 per cent.; ½ load, 93.2 per cent.; ¼ load, 88.4 per cent.; 1/10 load, 75.8 per cent.

Double-Pole Flasher.

The Reynolds Electric Flasher Manufacturing Company, of Chicago, is placing on the market an electric sign flasher for controlling circuits of from ten to one hundred amperes, which it handles in a most satisfactory manner. It is made with one, two, three, four, five, six or more double-pole switches having a capacity of 15, 35, 50, 75 or 100 amp. each. Thus from fifty to five hundred 4-cp lamps may be flashed on and off with one switch, and as many switches can be added as desired.

The switches are controlled by cams which close them automatically in any desired manner, producing any combination or flashing effect. With this flasher, electric signs can be flashed as a whole; double-face signs flashed alternately, each side as a whole; in the case of signs containing a number of words or lines, each word or line can be flashed separately, then all at once.

The mechanical and electrical construction is simple, there being few working parts and the construction being heavier and more sub-



DOUBLE-POLE FLASHER.

stantial. Its construction also avoids a multiplicity of circuits running through the flasher, as the division of circuits can be made at a cut-out box located in the circuit between the sign and the flasher.

The switch jaws are provided with self-lubricators in the shape of grease cups or pockets, as seen in the accompanying illustration, which hold sufficient grease to keep the sliding contacts perfectly clean and well lubricated for weeks without refilling. The switch blades drop from the jaws by gravity action as soon as they are released by the cams, thus insuring an instantaneous break and avoiding undue arcing. The switch blades as well as the jaws are made of the best grade of switch copper, thus insuring perfect conductivity.

"Reco" flashers are very simple to connect to signs. They require but one lead from each side of the sign and one return wire, or one positive and one negative from each word or line, and two or three mains from the service, according to the system; in other words, these flashers are simply cut in between the sign and the service and can be quickly installed to signs that are already up.

In the construction of its flashers the Reynolds Company has given careful attention to details with a view to the most satisfactory service.

Improvements in Storage Battery Details.

During the past year the Electric Storage Battery Company has developed and standardized a new method of booster control for use in connection with storage batteries installed for regulating work. This method involves the use of a booster of simple design, the field of which is controlled by a carbon regulator. This type of

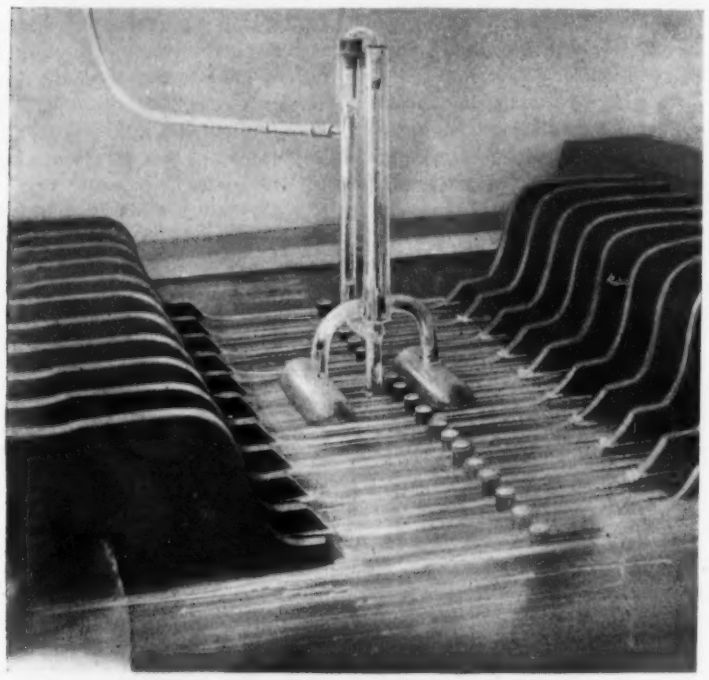


FIG. 1.—AUTOMATIC CELL FILLER.

regulator is a piece of apparatus which is mounted directly on the switchboard, occupying about as much space as an ordinary wattmeter.

The "Type R" storage battery plate, shown in Figs. 3 and 4, has been put upon the market by the same company for use especially in regulating batteries that are called upon for high rates of discharge. Figs. 1 and 2 show a new automatic cell filler and compensating hydrometer, the use of which simplifies the care of batteries and the work of obtaining records.

A number of important improvements have been made by the company in the details of remote control cell switches, for use principally in controlling batteries installed for central station service. It has also put forth a new form of jar for the larger sizes of batteries installed in glass jars, and which is much more substantial than the type previously used. This is shown in Fig. 5.

Roller Direct-Reading Bond Tester.

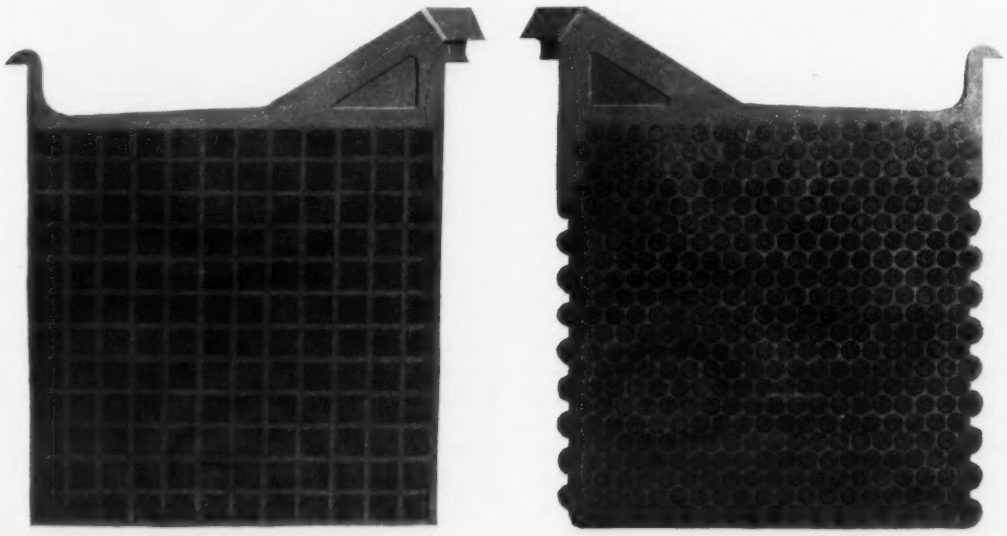
A convenient and practical form of rail-bond tester is shown in the two accompanying illustrations, the instrument being known as

FIG. 1.—BOND-TESTER IN USE.

the Roller direct-reading bond-tester, and made by the Whitney Electrical Instrument Company.

The instrument is supported by a strap passing around the neck of the observer, which strap, in conjunction with the cover—which opens downward at right angles to the top of the tester—holds the device constantly and securely in a horizontal position, as shown in Fig. 2. By adjusting the strap length the dial can be brought to a convenient distance from the observer's eye. In making readings the contact bar is connected up to the instrument itself by means of the flexible cords furnished for that purpose, all cords and binding posts being numbered, so that no mistake can be made in connecting. The bar is then put in place on the rail, with the two more closely adjacent rail contacts spanning the joint, whereupon the needle of the instrument will deflect from its zero position. Rotating the hard rubber button in the center of the glass cover of the dial will bring

FIG. 2.—HYDROMETER.



FIGS. 3 AND 4.—NEW STORAGE BATTERY PLATES.

FIG. 5.—NEW FORM OF JAR.

the needle back to zero, and when this is accomplished the position of the pointer, which is actuated by the hard rubber button, will show on the scale directly the resistance of the bond. If, for instance, the small needle stood at zero when the one actuated by the hard rubber button was at 6, as shown in the illustration, the bond under test would have a resistance equal to that of a six-foot length of rail.

When it is desired to ascertain whether the resistance of the bond is or is not greater than a predetermined amount, the needle operated by the hard rubber button is set to the predetermined value, which may, for instance, be four feet. When the contact bar is placed in position on the rail the small needle will then deflect either to the right or to the left of its zero position. If it deflects to the right the bond has a resistance of less than four feet of rail, and if to the left a resistance of more than four feet of rail. In periodical inspections of large systems this plan of making readings is most convenient and extremely rapid.

The range of the bond-tester includes all resistances from zero up to the equivalent of a length of 30 ft. of rail. In spite of the length of the scale—nearly 15 in.—the apparatus itself is compact, measuring but 5¼ in. by 8¼ in. by 7½ in. over all, and the weight is but six pounds. Bonds so poor that the drop across the joint is over two volts will in no way injure the instrument.

The contact bar device folds together into a compact package about 1½ in. by 3 in. by 36 in. The different portions of the bar are provided with recesses, into which the contact points fit, so that there is no danger of their catching on the clothing. A short strap binds the whole together. An apparently minor but really important feature of the bar is the construction of the contacts themselves. Each contact is formed of a piece of hack-saw blade about seven-eighths of an inch long, which is secured by a couple of screws in a heavy brass clamp. The length of the blade runs at right angles to the length of the rail, and, as the contact bar is made springy, each is forced to scrape along the rail when the bar is put in place, and hence make for itself a bright, clean surface. When the blades become at all dull they may be removed by slacking off the two screws, and a new piece, which can be broken from any hack-saw, can be substituted in a few seconds' time.

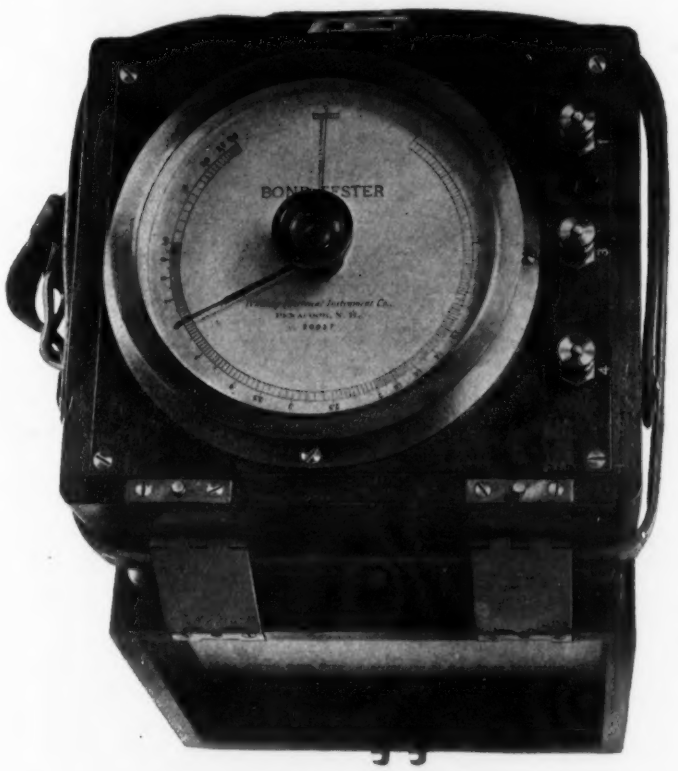


FIG. 2.—BOND TESTER.

Insulated Wire and Cable for Japan.

The Safety Insulated Wire & Cable Company, New York, reports such an influence of business that the Bayonne plants are now operating 20 hours daily. Some very substantial orders for insulated wire and cable are in hand for shipment to Japan. The U. S. Army Signal corps has requisitioned for a lot of submarine cable for Fort Washington, Md. ,

Portable Wattmeter Calibrators.

The Fort Wayne Electric Works has placed on the market two types of apparatus for calibrating wattmeters. One of these is known as a "Ringing Calibrator," and the other as a "Registering Calibrator." In the ringing calibrator a standard wattmeter of proper capacity, voltage and frequency, but without registering mechanism, is mounted on the inside of a wooden carrying case (Fig. 1). The case is provided with leveling screws and a small spirit level set into the base. In the case beside the meter is a double-pole, double-throw switch, by means of which the series coils of the standard can be connected either in multiple or in series for double or normal rated current.

For normal calibration of 5-amp. meters, with switch down the coils are in series; for double this current or 10-amp. meters the switch is thrown up. This prepares the calibrator for use with 5 and 10-amp. meters by direct comparison without a speed constant, the change in connections making no change in total ampere-turns or speed.

The scope of the calibrator is further magnified by using a speed constant of 2 for calibrating 15, 20 and 25-amp. meters. In this case the series coils of the calibrator are connected in multiple by throwing the switch up, in which case the calibrator will run twice as fast as these meters when it is in calibration. The calibrator will be accurate under these conditions up to 15 amp. load.

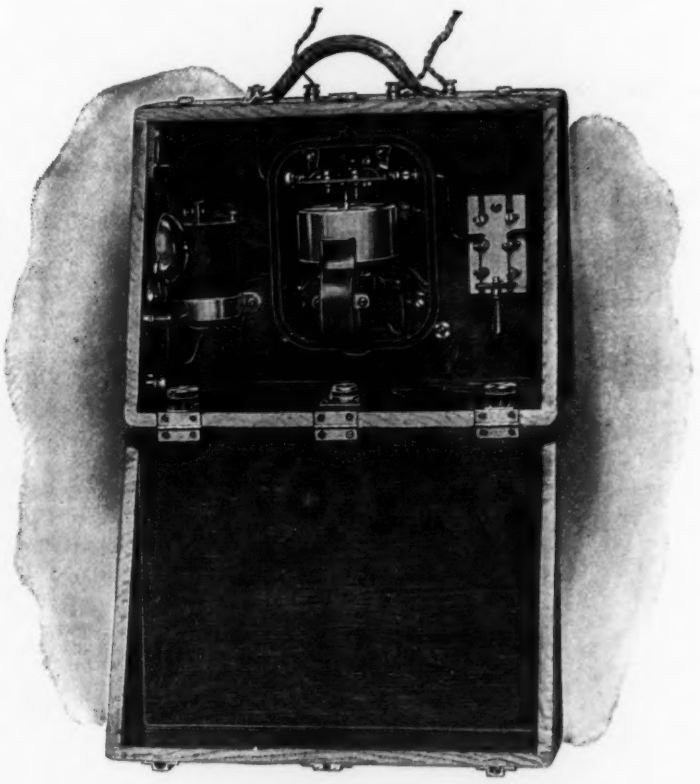


FIG. 1.—VIEW OF INTERIOR OF CALIBRATOR.

For comparing the speeds of the two meters a bell circuit is connected with the standard through a two-segment commutator on its armature shaft in place of the registering train. At every revolution of the standard armature the bell circuit is closed through a dry cell battery mounted on the left side of the case, thus ringing the bell. This bell circuit may be permanently opened when not in use by a two-point switch to prevent leakage of battery current should the armature come to rest with the commutator closed.

For calibrating a meter with the ringing calibrator the connections are as shown in Fig. 2. If the standard is properly connected in circuit the cup will rotate clockwise from above. Direction of rotation may be changed by reversing the voltage leads at the switch or fuse block.

With a heavy load the meter should be adjusted in step with the standard by its permanent magnet, so that the spot on the meter cup will always come to a certain point every time the standard bell rings for 5 or 10-amp. meters or every other time for 15, 20 or 25-amp. meters. If the meter is slow, the magnet should be lowered;

if fast, it should be raised. For light load or one lamp the adjustment is made with the starting coil arm. The standard meter used in the calibrator has a high permanent accuracy and seldom requires adjusting, as it will remain accurate for a long time if given considerate treatment.

The registering calibrator (Fig. 3) consists of a meter having the regular registering train replaced by a double reduction train and two dials instead of five. The dials register revolutions instead of kilowatts. This is a much simpler device than the ringing calibrator, but is much more restricted in its adaptability.

For carrying purposes a handle is attached to the meter frame.

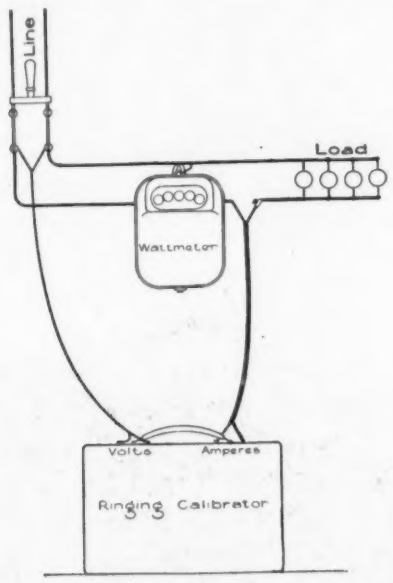


FIG. 2.—CONNECTIONS OF RINGING CALIBRATOR.

Two adjusting screws are provided on the bottom of the frame for leveling it for use, the third support being on the bottom of the case. The jewel bearing screw is extra long and projects through the case at the bottom, so that the shaft can be raised or lowered without removing the case which can be sealed and the adjustment of the standard protected from outside disturbances.

The calibrator terminals can be reached by removing the terminal cap. Line connections are made the same as with the ringing calibrator, the current leads going into the large binding posts and the voltage leads into the small posts. In use the calibrator is leveled

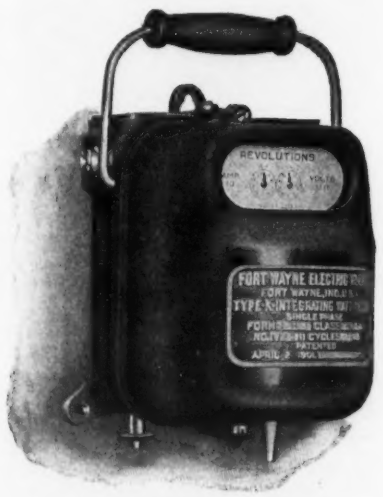


FIG. 3.—REGISTERING CALIBRATOR.

by a small level placed on a milled surface on the top of the base. The shaft is then lowered to the jewel. After the connections are made and the proper direction of rotation verified through the dial window the calibrator is ready for operation.

The dials of the calibrator will register 110 revolutions, which is equivalent to nearly three minutes running at full load. Therefore, if the revolutions of the meter to be tested are counted and compared with the difference in calibrator readings before and after counting, an exact comparison of speeds is obtained. This can be done very handily by one man. For first approximation one-half minute counting is sufficient, but for final accurate adjustment tne duration of comparison should be increased to two and one-half minutes.

Machine Tool Controllers.

No special line of electrical manufacture has perhaps received more attention and development than the variable-speed motor,

FIG. 1.—RHEOSTAT.

speed variation being obtained by field control. To meet the demand for field rheostats for motor control, the Ward Leonard Electric Company, of Bronxville, N. Y., has standardized and placed upon

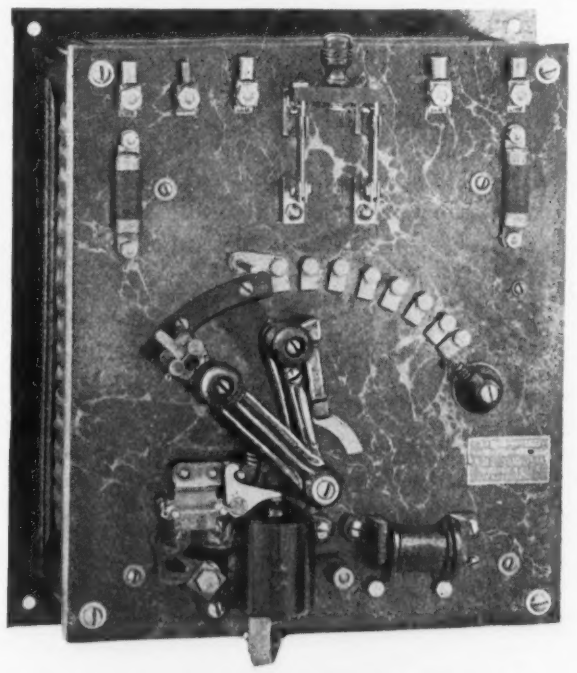


FIG. 2.—ARMATURE-CONTROLLING PANEL.

the market a line of field rheostats for variable-speed motor use. The demand is for a rheostat which is small in dimensions, but which must have a high ohmic resistance and an ampere capacity which is large upon the first few steps, but which is reduced greatly as the resistance of the rheostat is cut in circuit.

The accompanying illustration shows a rheostat having 24 steps, and 1,200 ohms resistance. The ampere capacity is tapered from 1.25 to .16 amp. The rheostat is built up of Ward Leonard enameled

resistance tubes, and each tube is a unit having four steps. The diameter of this rheostat is only 8 in. As these enameled tubes are stock articles, rheostats of any resistance up to 6,000 ohms can be quickly assembled. These rheostats can readily be supplied for back of board mounting.

The Ward Leonard Electric Company has developed a new armature-controlling panel. This panel controls the speed of the motor by armature control and will reduce the speed 50 per cent. The panel consists of an overload and no-voltage release controller, with an extension slate, switch and fuses. The back of the entire panel is enclosed in an expanded metal case. All terminals are brought out at the top of the panel. A notable feature of the controller itself is that the circuit is never made or broken upon the starting contacts, but is always made and broken at an independent point, and broken with a quick break. Arcing cannot occur upon the first live contact. All stationary contacts are of segment form and removable. The controlling lever is equipped with self-aligning, renewable skate shoe contacts. The no-voltage release magnet is dependent solely upon the line voltage and is entirely independent of the amperes in the field or armature. The overload device is a circuit-breaker, equipped with auxiliary hand trip and auxiliary arc-breaking contacts. The resistance is made up of Ward Leonard enameled resistance tubes. The resistance is entirely enclosed and is fire-proof.

High Potential Insulators.

Owing to the increasing demand for high-voltage line material, the H. W. Johns-Manville Company has developed a line of insulators much heavier and stronger throughout than its standard line. The high-potential round-top insulator (Fig. 1), has four petticoats giving large surface insulation and is well protected by a malleable-

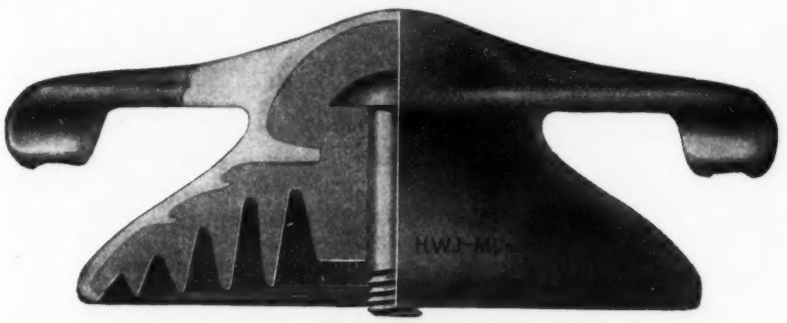


FIG. 1.—ROUND TOP INSULATOR.

iron shell, so that the possibility of surface leakage is reduced to a minimum. It was built specially for 1,500 to 2,000 volts for alternating-current trolley service, but owing to the great dielectric strength and large surface insulation, this insulator will prove equally efficient at much higher voltages. The same company has also de-

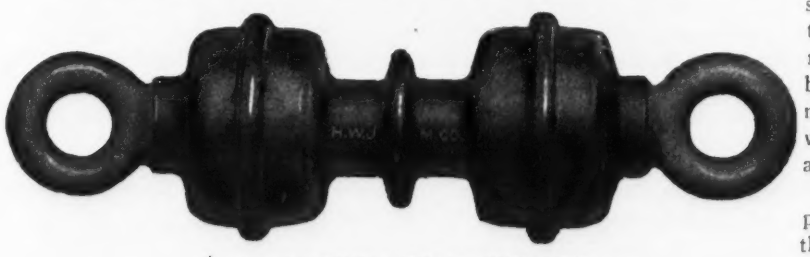


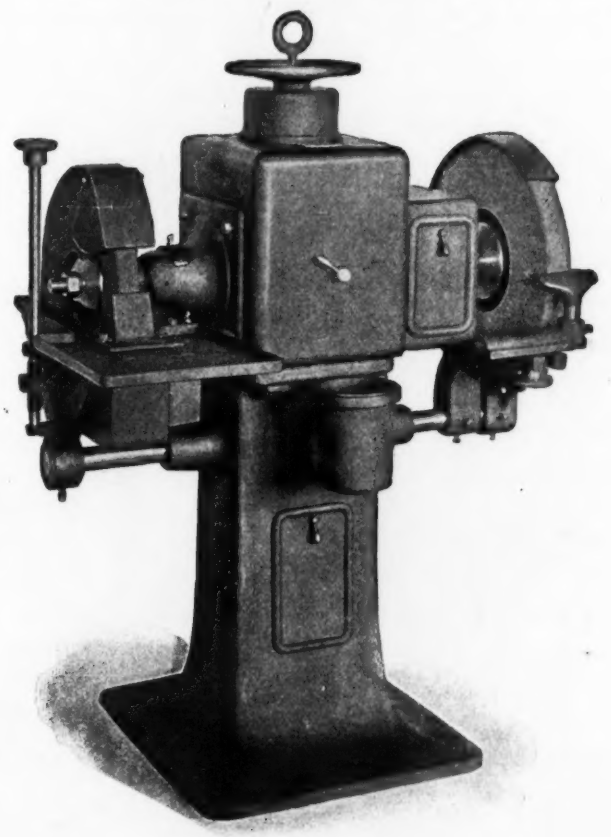
FIG. 2.—DOUBLE STRAIN INSULATOR.

veloped several strain insulators, of which one (Fig. 2) is a combination of two of its large "Giant" strain insulators coupled. The coupling is covered with moulded mica insulation, so that a continuous insulating surface is provided from eye to eye of the insulator approximating 8½ in. in length. This insulator is intended for strain work where the potential does not exceed 2,000 volts, but owing to the large insulating surface it may be used on higher voltages. Still another large type recently placed on the market is a strain insulator which has one inch of solid sheet mica through the center of the strain, insulating the metal parts from each other, and is built to stand a working pressure of 5,000 volts. This insulator has approximately 10½ in. insulating surface from eye to eye, and as in the case of the above insulators, could undoubtedly be used on higher voltages.

Electrically Driven Emery Grinder.

The accompanying illustration shows an electrically-driven stationary emery grinder recently introduced by the Stow Manufacturing Company, of Binghamton, N. Y. Among the leading features of this outfit is the motor, which embodies the special method of speed control used by the Stow Manufacturing Company in all variable-speed motors of its production. The variable-speed feature of the motor makes it particularly adapted to use in this connection, since the speed of rotation may be adjusted to give the proper surface speed of the wheel when it is new, and as the wheel is reduced in diameter, the speed of rotation may be increased, thus securing the advantage of constant surface speed at the wheel.

The size of grinder illustrated is the smallest in the line, the larger



EMERY GRINDER.

sizes being adapted to carrying wheels up to 24 in. in diameter. In the larger sizes these outfits are provided with independent bearings resting upon the pedestal, the smaller machines having the bearings bolted to the motor as shown in the cut. In designing this line of machines careful attention has been paid to the subject of bearings, with a view to making them ample in size and properly protected against flying dust from the stone.

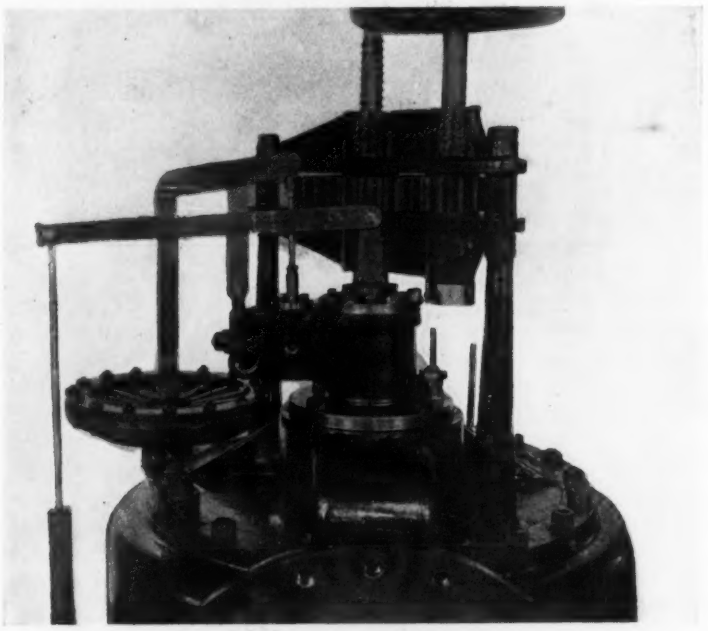
Very convenient means for starting and stopping the motor is provided by the short lever on the side of the motor, which connects the switch inside the casing, while the speed variation is secured by turning the hand wheel on top of the motor. Both wet and dry wheels may be used, as shown in the cut, a dry wheel being placed at one end and a wet wheel at the other. The wet wheel, mounted on the left side of the motor, is properly encased and the water tank below the wheel may be elevated to any desired height by a turn of the vertical rod shown on the extreme left. The level of the water is thus raised in contact with the wheel, and a more even distribution is possible than with the older foot pedal arrangement. Both wheels are provided with conveniently detachable rests for grinding, and the wet wheel has a catch pan into which the spray is thrown and returned to the water tank. A cast-iron water pot is conveniently located between the wheels.

Sturgess Hydraulic Relief Valve.

The object of the Sturgess relief valve, illustrated herewith, is to relieve automatically the pressure on a closed pipe line operating water wheels when the gates of the latter are suddenly closed, either by accident or by the regular operation of the governor. The pressure or "water-hammer" produced by such a closing movement of the gates is sufficient to endanger the penstock, and to burst it if the gate is entirely shut. The relief valve is designed to quickly open when the pressure in the penstock increases above that due to the static head, and to gradually close again as soon as the pressure in the penstock is restored to normal. By this means it not only saves the penstock but improves the regulation by preventing an excessive amount of water passing to the wheels during the closing action of the gates.

Within a body having a funnel-shaped connection for attaching to the penstock is a relief valve having lignum vitæ seats, the face of the valve being exposed to the pressure in the penstock, so that it opens outwardly. The back of the valve is formed into a piston which works within a cylinder in the upper part of the body. A connection between the cylinder and the penstock is made through a valve.

An outlet from the cylinder is provided by a valve which is controlled by a small piston, working within a cylinder. The passages to this cylinder are controlled by a pilot valve, which is in turn controlled by a weighted diaphragm above, the diaphragm being in



HYDRAULIC RELIEF VALVE.

communication with the penstock pressure through other valves.

The valve is designed to work in conjunction with the Sturgess water wheel governors, which have a tank containing oil under considerable pressure, the pressure being maintained by a pump. Oil from this tank is piped to the pilot valve to operate the control piston above referred to, the exhaust being led back to the pump.

In operation the counterweight is adjusted so as just to overcome the outward pressure on the diaphragm due to the water pressure within. This causes the pilot valve, to be raised just sufficiently to admit the oil pressure above the control piston, causing it to hold the cylinder outlet valve down on its seat. The water from the penstock, flowing through fills the cylinder above the penstock valve and causes it to be held down on its seat, against the pressure in the penstock. This is due to the greater area of the cylinder over the valve exposed to the water pressure.

The pressure in the penstock now rises, due to the closing of the gates. This increase of pressure is felt by the diaphragm which overcomes the balance weight, and causes the pilot valve to move sufficiently to admit pressure beneath the piston. This raises the cylinder valve off its seat, relieving the water in the main cylinder. The valve now being unbalanced, is thrust open by the water acting on its exposed area and the discharge takes place, relieving the pressure in the penstock. As soon as the pressure is relieved, however, the diaphragm will go back to its normal position reversing the movement of the piston so as to again close the cylinder valve. The water, which has been running all the while through the penstock valve, now fills up the main cylinder as before, gradually closing the valve.

Two connections are made from the diaphragm to the penstock through valves. One of these valves is connected to the penstock at a point close to the relief valve, where the velocity of the water is high, and the other one, to a more remote point of the penstock, where the velocity of the water in the penstock is comparatively low. By partially opening both these valves to a varying degree, the amount that the valve shall open for a given rise in pressure can be readily adjusted. The rate at which the valve shall close again is adjusted by the penstock valve. For the purpose of closing the valve by hand, so as to enable any of the working parts to be removed, a supplementary hand closing gear is provided, consisting of a screwed stem geared to a hand wheel. The stem, when run down, holds the valve upon its seat, but when the valve is working the stem is drawn up out of the way.

The discharge from this valve should be piped into the tail-race and sealed so as to prevent freezing, and in order to get the full opening of the head available. As the water is thus piped away the relief valve can, if desired, be set in the generator room, where it will not be subject to severely low temperatures, and thus the winter troubles, to most relief valves, will be avoided.

Sturtevant Generating Set.

In response to the growing demand for a high-class generating set at a reasonable price, the B. F. Sturtevant Company, of Boston, Mass., is manufacturing a type illustrated herewith. The general design of the engine embodies all the latest improvements to the horizontal type. The reciprocating parts are substantially constructed and counterbalanced with lead load discs. A feature of construction is that of forging the crank shaft solid in one piece and shrinking the discs onto it. A special arrangement of the Rites governor gives a regulation within 1 to 1½ per cent. from full load to no load, and by a modification of the Marshall valve gear an adjustment of the cut-off from zero to 70 per cent. is attained.

The main bearings, crankpin, valve stem and slides of this engine are well babbitted with the Sturtevant white metal. A recent and important improvement is a water-shed partition which prevents the water from the piston rod stuffing box from reaching the interior of the engine frame, and the oil on the reciprocating parts from being thrown out into the engine room. The main body of the engine is enclosed on both sides by removable plates, as may be seen from the cut, and the crank webs are enclosed by a cast-iron hood having two holes with removable covers, one for the purpose of cleaning the crankpin box while it is in motion and the other for removing the box without taking off the large hood. Between the watershed partition and the front end of the cylinder is a hand hole for reaching the stuffing box bolts without communication to the oil spaces.

There are two oiling systems for this type of engine, the gravity or tank system and that by forced pump lubrication. With the gravity or tank system, shown in the illustration, an oil tank supplies the pipes leading to the parts to be oiled. At each point where the oil is delivered is a little gauge glass and valve for regulating the flow at that point. A valve just below the tank regulates the entire oiling system.

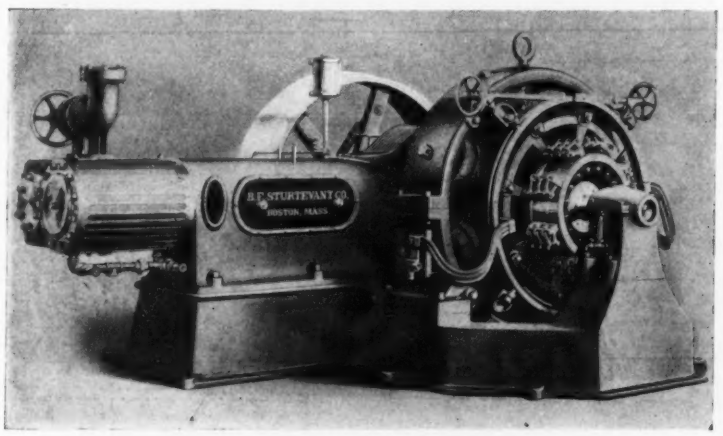
With the pump, or forced lubricating system, a pump is located in the base of the engine and is operated by the crank shaft. Oil is delivered from this pump to the main bearings and from the main bearings through holes in the crank shaft and web to the crankpin. From this point the oil is conducted up through a hole in the connecting rod to the crosshead pin. A separate set of pipes conveys the oil from the crosshead guides to the valve stem guides. The pressure of oil in the bearings under this system will vary from 12 to 18 pounds per sq. in. The mechanical efficiency of the engine is so materially increased by this system of lubrication that its demand is rapidly increasing. Practically all engine builders will soon be obliged to provide for it to keep abreast of the times.

The generator of this set is of the eight-pole type, and is capable of carrying momentary overloads of 50 per cent. without any shifting of brushes or flashing of the commutator, and an overload of 25 per cent. for a period of two hours without undue heating. After a

continuous run of ten hours at full load the increase in temperature above that of the surrounding air never exceeds 40° C., upon the armature and field coils, and 45° C. upon the commutator. The average temperature rise is about 33° to 35° C. Before being shipped, the generator is given a breakdown test of 1,500 volts, alternating, for 60 seconds, between the conductors and the frame of the machine, to test the insulation.

The magnet frame is of the very best grade of cast iron, split horizontally. The pole pieces are of wrought iron with cast-iron shoes or horns and are secured to the magnet frame by through bolts. Any of the pole pieces may thus be removed to repair the field coils. The latter are wound up in two sections, with an air space between the shunt and the series coils. The shunt winding is of double cotton-covered magnet wire of highest conductivity, thoroughly insulated and so treated as to be practically water-proof. The series winding is of solid copper bars insulated in the same manner as the shunt coil.

The armature is of the iron-clad, form-wound, ventilated drum type, having a core built up of charcoal iron plates, which plates, after being thoroughly japanned, are mounted upon a cast-iron spider and securely held in position by end flanges. No bolts pass through



GENERATING SET.

the armature laminations. The armature spider has an extension upon which is mounted the commutator making the armature and commutator one unit.

The armature conductors are solid copper bars, without joints, except at the commutator end. When these bars are formed they are insulated by material not perceptibly affected by heat or ordinary atmospheric moisture.

In the construction of the commutator only drop-forged or drawn segments are used, these being secured in cast-iron shells of spider construction and clamped in place with a steel ring. No cast segments of any nature whatever are used. The segments are insulated with the best quality of carefully selected mica of a degree of hardness to allow the mica and segment to wear uniformly obviating trouble from high mica. The end insulation consists of micanite rings and the whole commutator is assembled while hot, under great pressure. Carbon brushes only are used, the commutator being so proportioned and the brushes of such size as to allow at least one square inch of brush area to every 30 amp. carried. These brushes are carried in holders of most approved construction, each mounted upon a self-contained brush rigging so arranged that the entire set of brushes may be rotated completely around the commutator. Hand wheels for adjusting the brushes in position are so located that the brushes may be adjusted from either side of the generator.

Motors for Atlas Cement Works.

The Atlas Cement Co. has placed a contract with the C. & C. Electric Co. for a number of motors to be installed at its Hannibal, Mo., works. There will be 42 machines in all. They will range from 15 hp to 30 hp in capacity. The aggregate hp will be 810. The motors will be used for driving cement machinery. Twenty-six of them will be of 20-hp capacity, and of variable speed, 400 r.p.m. to 900 r.p.m. obtained by field control. The voltage will be 500. These machines will be equipped with Cutler-Hammer special starters for speed-regulating rheostats.

Numbering Metal Parts.

We show herewith some specimens of numbering in metals made by a small automatic machine specially designed to meet every requirement in this line. These machines are provided with straight or tapered shanks of any size desired, and are used in regular punch presses of suitable capacity. They are set up, adjusted and operated in much the same manner as an ordinary punch. Flat surfaces are

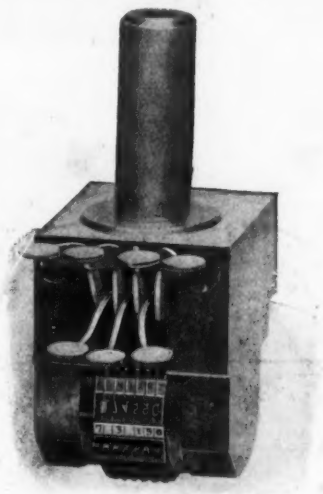


FIG. 1.—NUMBERING MACHINE.

numbered with straight alignment of figures, or the alignment may be curved to correspond to almost any radius, and thus improve the appearance of the numbering, or by economizing space, increase the size and legibility of the figures. Letters or characters of any kind are provided, and any combination of them with figures may be instantly set in stamping position. Any size, style or shape of figure may be used, and any metal which can be machined is capable of being numbered by this process.

Referring to Fig. 2, *A, D, E* and *G* are pieces of brass and *B, C, F* and *H* are hard-rolled steel stock. In *D* it will be observed that not only is the alignment curved, but the position of each figure radiates from a common center, while in *C* the alignment is shown curving in the opposite position with the figures parallel to each other. *D*, with the number in the form of a letter V, shows one of the more difficult propositions, and was made for a well-known watch case manufacturer, a design being placed above the figures

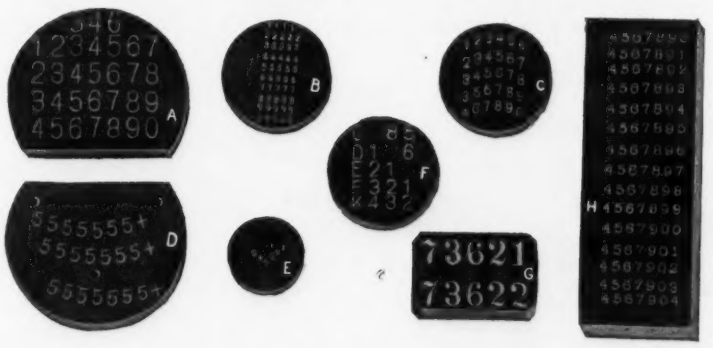


FIG. 2.—NUMBERING ON METAL.

and partly extending into the top of the *V*, thus producing a trademark easily recognized.

This system of numbering, however, is not confined to flat surfaces, and it is practicable to number round, convex, concave and other surfaces presenting various radii. In Fig. 3 *K* is a piece of shafting, 1½ in. in diameter, and to number it the faces of the figures were made concave. *J* illustrates an embossed number. The material is thin, soft brass (.006), and the machine was designed for numbering gas meter tags. The entire number with the panel was embossed at one stroke of the press, and the number automatically advanced. *I* is a set of standard adjustable dies. The match number is placed upon the back of each half of the die before the parts are finished and separated, thus assuring correct assembling. Machines with double numbering movements for numbering both parts

at one operation are used by some manufacturers. It will be observed that the illustrations show a high degree of excellence in the matter of the alignment and spacing of the figures, while the depth to which they are sunk is always uniform. The numbering is absolutely accurate, and in many instances the saving of time is so great that the entire equipment pays for itself in a few weeks or

FIG. 3.—NUMBERING ON METAL.

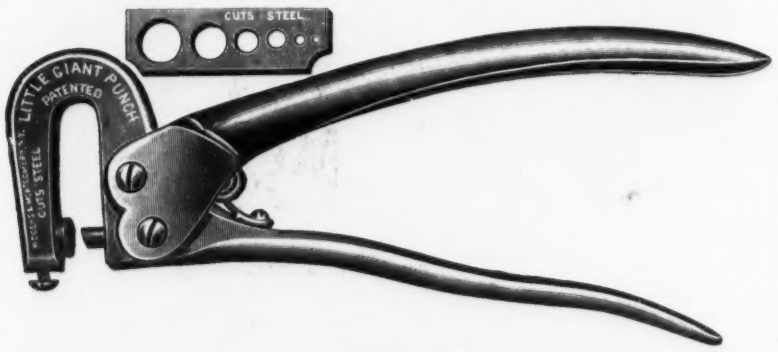
months, according to the extent to which it is used. Usually it becomes boy's work, and after the job is once set up an average of 1,000 pieces per hour can be numbered, or even greater rapidity attained, as the feeder becomes expert.

The equipment is manufactured by the Bates Machine Company, 346 Broadway, New York, and 2 Cooper Street, Manchester, England.

"Little Giant" Hand Punch.

A new hand punch, illustrated herewith, is being placed on the market by Rogers & Montgomery, successors to The Rogers Manufacturing Company, 147 West Twenty-third Street, New York. This punch, which is called the "Little Giant," is at present made in two sizes, one for punching holes from 1/16 in. to 7/32 in. diameter and the other for holes of from ¼ in. to ½ in., inclusive. The first-mentioned punch, which is shown in the cut, is guaranteed to punch easily a clean 3/16-in. hole through No. 20 gauge sheet steel or galvanized iron, or No. 16 gauge sheet brass or copper.

In addition to working sheet metals, the punches are also especially



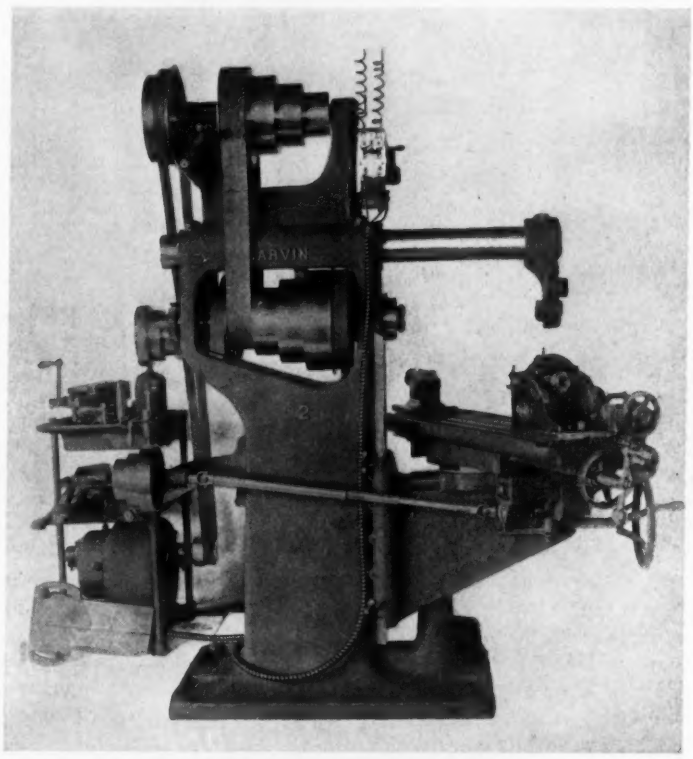
HAND PUNCH.

adapted for punching leather, cloth, celluloid, slate (without cracking), wood, bamboo, rubber, books or paper of any thickness up to the width of the opening between the punch and die. The design of the punch is such as to give an unusually great leverage, as a pressure of one pound exerted on the handles gives fourteen pounds at the point of the punch, and it is this great leverage, together with the high-class materials and workmanship, which enables these hand punches to do work of many kinds formerly requiring the use of a punch press or drill press.

Both sizes of punches are 7 in. long over all, the larger having a slightly enlarged head to admit the larger sizes of punches and dies. Interchangeable sets of punches and dies for the smaller punch run by differences of 1/32 in. diameter from 1/16 in. to 7/32 in., and by differences of 1/16 in. diameter, from ¼ in. to ½ in., inclusive, for the larger punch. The parts are drop-forged from steel and the assembling screws are case-hardened. The punches and dies are made from finest tool steel, properly tempered and hardened. The tool is polished and heavily nickel-plated and fitted with a coil wire spring for expanding the handles.

Universal Milling Machine with Motor Drive.

In applying the motor drive to its milling machines, the Garvin Machine Company, of New York, has adopted the arrangement shown, which illustrates its No. 2 universal milling machine with motor drive. This is a simple and elastic design, adapted to any style or make of machine, without alteration in the machine itself.



ELECTRICALLY-DRIVEN MILLING MACHINE.

Changes of speed and reversal are conveniently made, and the efficiency of the drive has been demonstrated by severe tests.

A constant-speed, completely enclosed motor is used, which is set in the bottom of a tool tray placed just behind the machine. This stand makes an excellent place for the motor, which is thereby protected, and requires no extra floor space. A starting box and switch and safety fuse are located directly in front, above the arm. The whole apparatus is held in one frame, which is bolted to the upper part of the miller base.

The driving cone above the spindle runs loose on a hardened and ground shaft, carried in eccentrics at each end. The shaft is raised and lowered by rotating the eccentrics by means of a worm gear and crank handle at the rear end, so that the belt can be easily strained up for driving, or slackened off for shifting. An oil reservoir is formed in the hub of the cone, and supplied from a pipe at the end of the shaft.

Running loose on the rear outer end of the same shaft, and oiled through the center of the shaft, is a large two-step cone, for a narrow belt which connects down to the motor. This two-step cone is geared to the main cone to reduce the speed, and the intermediate gear shaft is hardened and ground and fitted with a ring oiler. The gearing is carried by the flange of the rear eccentric, so that the running is not affected by the position of the shaft. The light, fast-running belt to the motor is easily shifted, giving two speeds corresponding to the two speeds of the friction pulleys on the ordinary countershaft, and together with the main cone, and the back gears on the spindle,

sixteen changes of speed are obtained. For reversing the long length of the narrow belt down to the motor permits of crossing as readily as shifting, and without any appreciable difference in tension.

Putting the motor below secures lightness and simplicity, and avoids any vibration and topheaviness in the frame above. The main driving belt is double thickness, and arranged as it is with tightener, will easily transmit the full power of the motor, without the least heating of bearings.

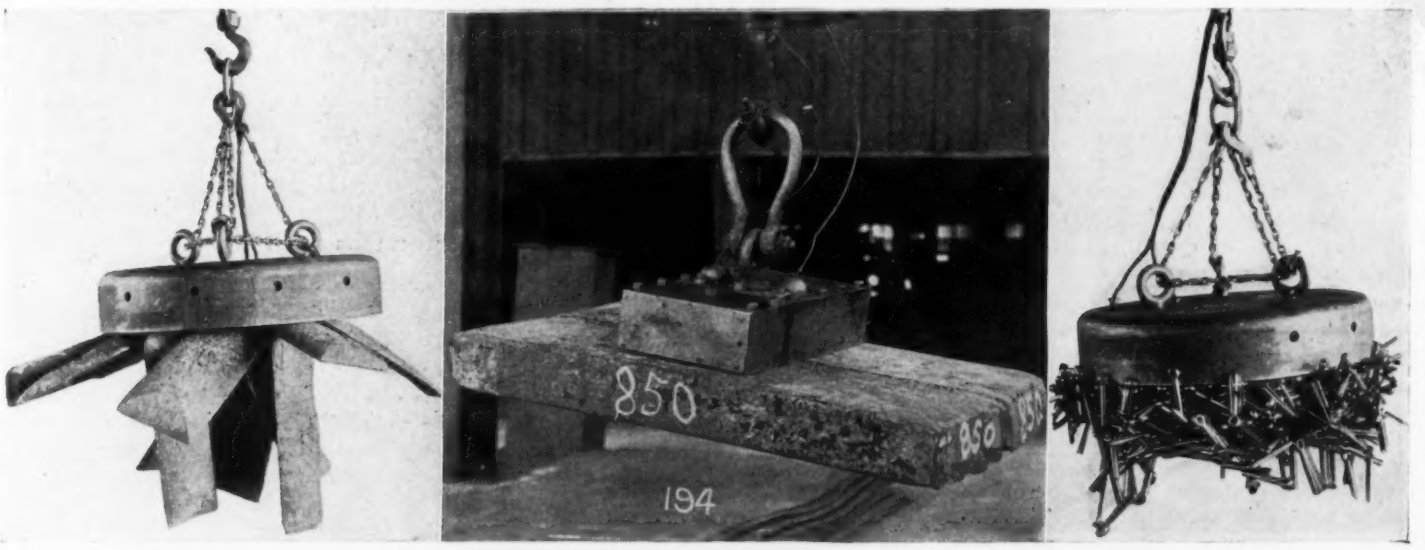
Electromagnets for Lifting Purposes.

Wherever steel or iron is handled in quantities by means of cranes, a lifting electromagnet will in most cases effect economies in time and labor sufficient to pay for itself in a short time, as has been borne out by experience in steel mills, jobbing houses, safe works, etc. In all cases the electromagnet is suspended from the hook of the crane, direct current at any of the common voltages being employed to energize the magnet. A flexible twin conductor cable is used to convey the current to the magnet and a small switch operated by the crane man is usually the only additional apparatus necessary. The amount of current used is small, being from one to twelve amperes, according to the service for which the magnet is designed.

In operation the magnet is lowered upon the material to be lifted, and the switch closed, thus causing the magnet to attract and hold the material, which may then be hoisted by the crane and transported to the desired point. By simply opening the switch the material is instantly released.

Comparing this method of operation with the common methods of connecting the load to the hook of the crane, with chains, hooks or clamps, a saving in both labor and time is apparent, as, in general, the attachment of the magnet to the load, as well as the release of the load, may be accomplished by the crane operator without assistance, thus saving the labor of one or more men for prying up the material, attaching hooks and chains at the point of loading and additional men at the point of delivery for unhooking the load from the crane. Moreover, magnets can be so quickly attached to and detached from a load that by their use the work which may be done by a given crane is greatly increased, in some cases more than doubled. It frequently occurs that the attachment of lifting magnets to existing cranes so increases their capacity for handling material that the purchase of additional cranes for handling an increased output is rendered unnecessary. Since lifting magnets require much less head room than hooks or chains, material of considerable width such as plates can be conveniently piled to a greater height in the storage space under a given crane than is possible when chains are used, thus increasing the capacity of a given storage space without altering the crane runway or increasing the size of the building.

The magnet should in every case be designed to meet the form of material to be handled, since there is a wide difference in the design of a magnet for lifting ingots or blooms and one adapted to the handling of thin plates. A magnet which would handle five tons in the form of an ingot might not handle 500 pounds in the form of thin plates. It is therefore necessary to understand in each case the operating conditions with special reference to the form and range of material to be handled. As to risk of accident, the Electric Controller & Supply Company, Cleveland, Ohio, state that in their experience with scores of their lifting magnets in successful operation it has yet to learn of a single accident which has occurred through their use, while, on the other hand, accidents due to the slipping and breaking of hooks and chains are known to be of very frequent occurrence. The accompanying illustration shows some of the applications of lifting magnets as made by the above-mentioned company.



FIGS. 1, 2 AND 3.—LIFTING MAGNETS.

Arc Lamp Tests.

An arc lamp test of Toerring constant-potential series lamps was recently conducted by Messrs. Dodge & Day, modernizing engineers, which included a carbon life test as well as a critical study of the design, regulation and burning of the lamps. We quote below from their report:

In the carbon life run the line voltage was kept constant at 232 volts. The first lamp burned 216 hours, at which time its cut-out went into operation and the second lamp continued burning, reaching a total life of 233 hours. The average current was 4.75 amp.

The life test was made with the casings off to permit easy running of voltmeter wires into the lamps and to permit of closer observation. A subsequent heat run of 5½ hours with the cases on showed the temperatures of the various parts of the lamps to be reasonably low. The temperatures of all the series coils was about 69° C. The casing was quite warm near the top, or just outside the resistance coil, at which point it was about 85° C. It was much cooler lower down. As the shunt coils are protected by a paper case their actual heating could not be determined, but it was certain that they were not at an unduly high temperature.

A "rushing" test was made to determine the current taken by the lamps at the instant of throwing on the current. When cold the current rushed to 7.1 amp., dropping to 5 amp.; hot, the rush was to 6.4 amp., dropping to 4.7 amp.

The upper carbon holder of this lamp is fed by means of a flexible cable attached to a ring at the upper end of the former. This ring slides up and down along a slot in an inner brass tube supporting the clutch. The slots in the main tube and clutch tube are 180° apart. Access of air to the inner globe is thus rendered difficult, and to this feature may be attributed the uniformly long life of all Toerring lamps. Messrs. Dodge & Day reported that in this respect they found them greatly superior to any other make of lamp which has come under their observation.

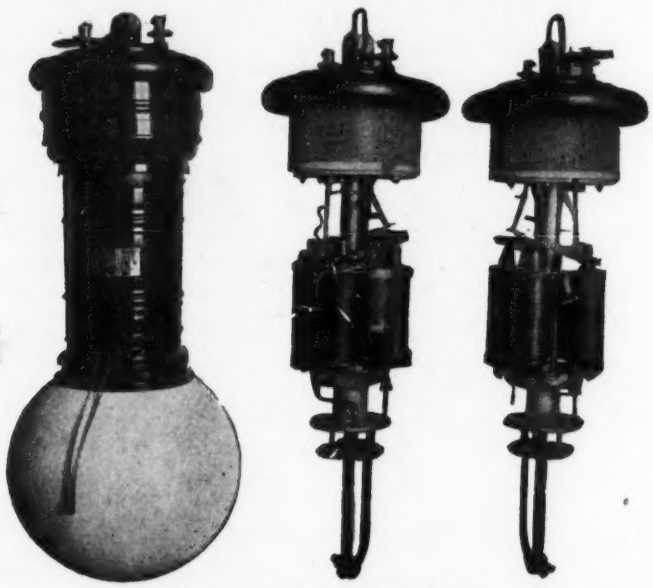
Attached to the shunt armature is the cut-out, shunting the arc current through a section of resistance in the head of the lamp. The contacts are flat brass pieces about 1 in. by ½ in., and the lower one is fastened in the center by a single countersunk screw which is loose, so that the contact piece may move, thereby making good contact with the upper one.

The two pairs of coils—series and shunt—are each fastened at the bottom to a strip of soft iron to complete the magnetic circuit. Each strip is, in turn, screwed to a thin plate, resting upon the main casting of the lamp and fastened by four machine screws. The casting is of iron nickeled and is very strong; into it is screwed the frame tube.

The clutch is attached directly to the inner tube by a straight piece and is of the same type as formerly used. Its action during the test was very good.

From the lower flange on the casting and about 1¼ in. below it, is hung, by two supports, the round iron plate to which is fastened the lower carbon holder. The flange on the main casting, which is flat on its under side, forms the bearing surface for the upper edge of the inner globe.

The lower carbon holder they considered a great improvement. It is made of two iron strips riveted together, which are spread out



FIGS. 1, 2 AND 3.—ARC LAMPS.

at right angles at the top and fastened to, but insulated from, the lower plate by two machine screws. At the bottom of the strips is fastened, by two screws, the holder proper, which is a small casting with a T head set-screw for clamping the carbon. The carbon holder being in two parts, the clamping piece can easily be replaced when burned. The main part of the holder is not so liable to break as a cast-iron one. The T head screw on the holder is of a very good shape and is well adapted for clamping the carbon by pliers when the lamp is hot. In conclusion, they state that, in general, this lamp shows good design. The general operation on test was excellent. The lamps burn either two in series on 200-250 volts or five in series on 500-550 volts, respectively.

Self-Retrieving Trolley Stand.

Since the advent of the electric system a great many devices have been produced with a view to protecting span wires, trolley poles and roofs of cars. A great many of these devices are in use on various roads throughout the country at the present time. Nearly all of these devices have been in the nature of retrievers fastened to the end of the car in such a manner as to pull down on the trolley cord when the wheel leaves the wire, thereby preventing serious accidents both to life and property. The Wesco Supply Company, of St. Louis, began an investigation of this problem about two years ago and finally evolved the idea of making a practicable automatic stand combining the retriever and stand in one.

The action of the wheel in leaving the wire operates the stand and the pole falls to a position of about 30° and remains locked in that position until relieved by the conductor, who pulls the pole by means of the rope to a horizontal position, when the wheel and entire stand is again ready for service. It was found in the experiments and tests with different devices that the cause of the wheel leaving the wire was that the base pins were too short to carry the loads put upon them; flat planes, therefore, being worn upon the pins and in the casting of the base proper. Further investigation developed the fact that the stand formerly used having high pins gave better satisfaction, aside from the breaking of the springs, than the low ones and it was, therefore, decided to build a 12-in. stand. After short service flat planes are worn upon low pins and instead of serving as a swivel, they become riding, so that when the car sets up a rocking motion the wheel is thrown from the wire because of the rigid condition of the base. As the device is not yet ready for the market, a description in full detail cannot be given at the present time.

Commutator Truing Device.

The accompanying illustration shows the Jordan commutator truing device as in actual use on a 100-kw Westinghouse direct-connected unit. The device in this case was subjected to a very severe test, owing to the fact that the commutator had become worn to an oval shape, the smaller diameter being about ⅛ in. less than the larger

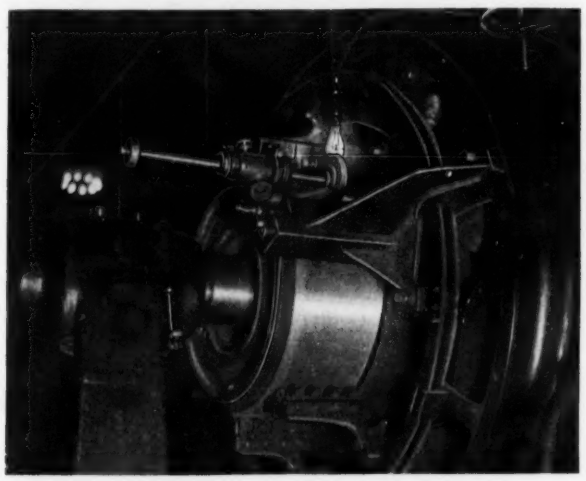


FIG. 1.—TRUING COMMUTATOR.

diameter. While this device is suitable for small machines, it is also particularly applicable to commutators of large diameter. Fig. 2 shows the truing device in detail. The large disc at the left is the grinding wheel especially made for the purpose and conditions under which it is used. This is fed across the commutator by the fibre hand wheel shown on the right. The thumb nut shown on the top holds the arm rigid to the grinder after the feed is made.

As will be seen, the mounting of the grinder is such as to permit it to be exactly adjusted to its work. The small wheel to the left is an idler or tension pulley to tighten the belt as the grinding wheel

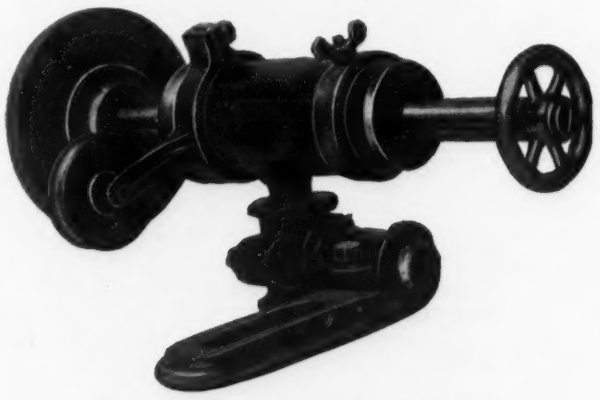


FIG. 2.—DETAILS OF TRUING DEVICE.

is fed toward the commutator, the driving pulley of the device being the pulley surface shown directly opposite the driving wheel. The manner in which the device was driven in the case of the 100-kw machine is shown in Fig. 1, the belt in this case riding in a groove at the end of the commutator. The speed of the device is adjusted so as to be not less than 5,000 ft. per minute, and a single cut up to 1/64 in. may be taken at one feed. This device is made by Jordan Brothers, 74 Beekman Street, New York.

New Westinghouse Railway Motor.

The Westinghouse Electric Manufacturing Company has replaced its railway motor known as No. 56, by a new motor, to be known as No. 93, in which, while retaining the good features of the type superceded, a number of improvements have been introduced to meet successfully the increasingly severe demands of the city, suburban and interurban service for which it is adapted.

In city service a double equipment of these motors is suitable for

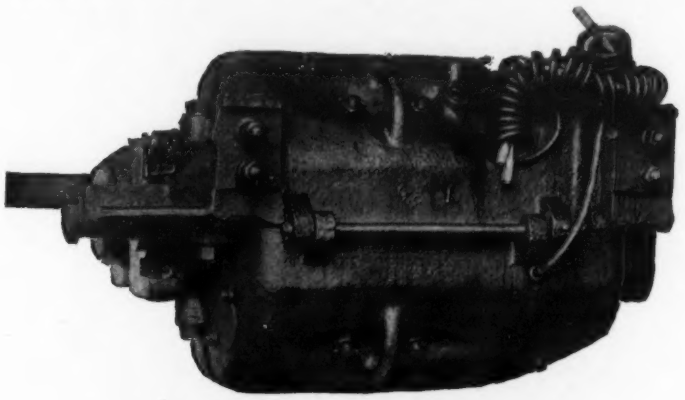


FIG. 1.—MOTOR CLOSED.

operating single or double truck cars of almost any size ordinarily used, that is, cars not exceeding 35 to 40 feet over all, and weighing, without equipment or load, from 23,000 lbs. to 30,000 lbs. In this service, with runs from ⅛ mile to ¼ mile in length, a two-motor equipment with a gear ratio of 16 to 71 will produce a schedule

FIG. 2.—ARMATURE.

speed of 10 to 13 miles per hour, assuming a pressure of 500 volts and a straight level track. In suburban service a four-motor equipment will operate cars from 40 ft. to 45 ft. over all, and weighing from 30,000 lbs. to 35,000 lbs. without equipment of load. In this service, the average load being from ¼ mile to ¾ miles, the four-

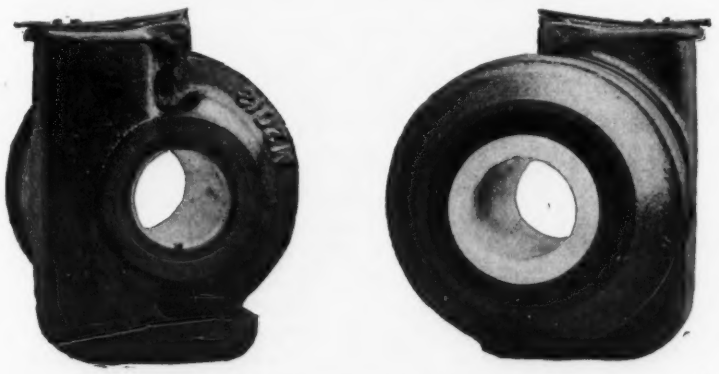


FIG. 3.—BEARINGS AND BEARING HOUSINGS.

motor equipment will maintain an average speed of approximately 17.5 miles per hour with gear ratio of 19 to 68 under the conditions previously stated. In interurban service, with an average run of from ¾ mile to 1½ miles in length, and with equipment and weight of car as above, schedule speeds of 23.5 miles to 28.5 miles per hour may be attained.

The general performance of this motor is shown by the curves herewith. The motor has a nominal capacity of 50 hp at 500 volts for one hour. The curve sheets show the speed, tractive effort, and the brake horse-power which it will develop with currents of from 0 to 200 amp. at 500 volts, also a time-temperature curve.

The motor has a continuous capacity of 50 amp. at 300 volts, or

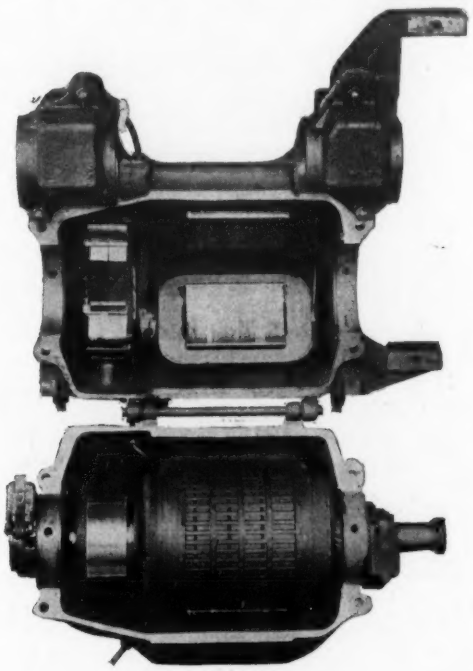


FIG. 4.—FIELD OPEN SHOWING ARMATURE.

46 amp. at 400 volts. Under the usual conditions of railway service, it will carry safely any loads within the range shown on the

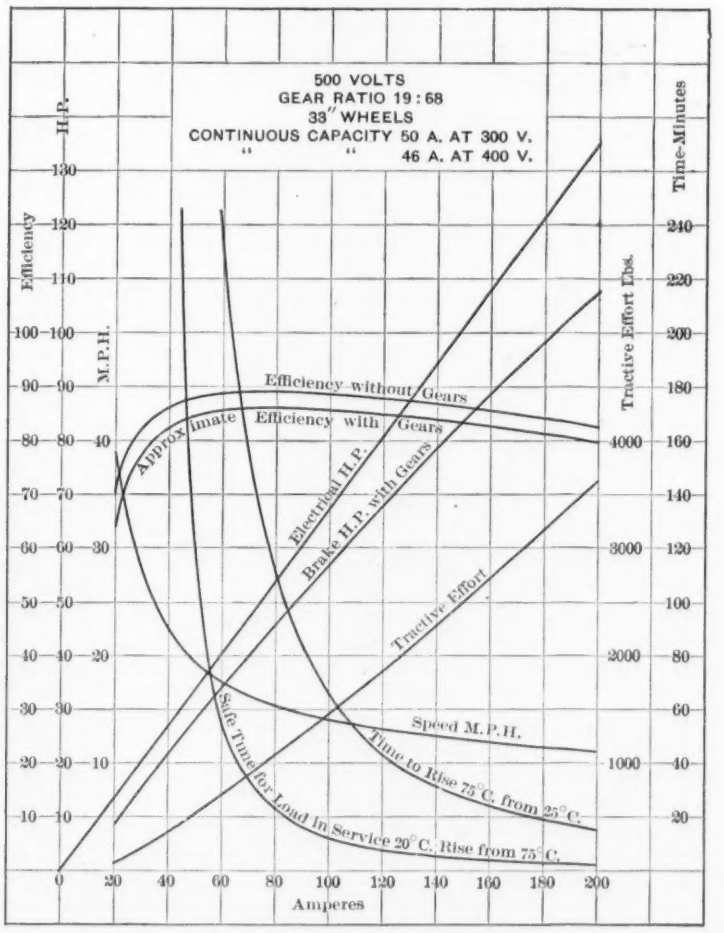


FIG. 5.—PERFORMANCE CURVES.

curve sheets, provided that the integrated heating effect does not exceed the heating effect caused by the continuous application of the above currents at the corresponding voltage.

In a shop test at either of these loads, the rise in temperature of

the windings of the motor during an all-day run, will not exceed 75° C., as measured by thermometers. With the motors mounted under a moving car much better ventilation is obtained than in a shop test, and thus the temperature rise in service with the equivalent of these loads should be considerably less, and will usually not exceed 55° C. For short periods, such as the rush hours of service, the motor may be operated with loads in excess of its continuous capacity, and under these conditions it will reach a temperature higher than the above, though still within safe limits.

The time-temperature curve shows the allowable amount and duration of such loads. The curve is based upon a rise in temperature of 20° C. in the interior of the coils under service conditions, after the motor is already heated to its ordinary running temperature. Thus, if the motor has been working for ten or twelve hours at a load equivalent to 47 amp. at 300 volts, and has attained a temperature of 55° C. above the air, it may then, as shown by the time-temperature curve, carry loads equivalent to a continuous current of 110 amp. for 10 minutes with a further increase of not more than 20° C. If at the end of this period the load is again reduced to the equivalent of 50 amp., the temperature will then gradually fall off to its former value of 55° C. above the air. The time-temperature curve thus shows what may be termed the safe overload capacity of the motor.

Every part of this motor is rigidly tested while in process of manufacture, and after being assembled, a run under full load is made, in addition to a "breakdown" test of the insulation, at an alternating potential of 3,000 volts.

The approximate weights are as follows: Motor, without gears and gear case, 2,975 lbs.; motor, complete with gears and gear case, 3,335 lbs.; armature, complete, with commutator and shaft, 1,005 lbs.. The approximate weight of a two-motor equipment with two controllers and the usual details is 7,870 lbs. A corresponding equipment of four motors, controllers, etc., will weigh approximately 15,940 lbs.

Receptacle for Decorative Lighting.

A new receptacle intended for temporary decorative wiring has just been placed on the market by Pass & Seymour, Inc., Solvay, N. Y., and is shown herewith. This is claimed to be the simplest receptacle for the purpose ever designed. It is not necessary to take the receptacle apart to wire up, or to remove or in any way

RECEPTACLE.

manipulate the insulation of the wire. The illustration shows clearly the extremely simple method of wiring of which this device admits. It is designed for Edison base only, and to be used with standard stranded wire. The manufacturers have under consideration the possibilities of renting these receptacles for short periods of time, which matter they will be glad to take up with the electrical trade.

Storage Battery for Sparking Use.

The storage battery for sparking does not require recommendation to automobile use. The advantages of its high constant voltage and large volume of current are at once evident, and its use obviates any guessing as to whether it is the battery or the spark plug, which is giving trouble. The automobile has called for a special type of battery for this use, and the "Reliance" igniter storage battery, made

SPARKING STORAGE BATTERY.

by the Storage Battery Supply Company, 239 East Twenty-seventh Street, New York, has been specially designed to meet this demand.

The "Reliance" battery is put up in celluloid jars, this material lending itself in many ways toward making the ideal battery jar. With it the interior of the battery may be seen as clearly as if it were in glass, and being much tougher than hard rubber, it excels in strength also. But perhaps the greatest value of celluloid lies in the facility with which it can be hermetically sealed at all joints, including the cover, thus making a battery free from the annoyance of moisture and corrosion due to the usual method of waxing the covers of the hard rubber jars. Celluloid jars have been largely used by European automobile manufacturers, and are now placed at the disposal of American users.

Blake Insulated Staples.

The accompanying illustration shows a type of insulated staple for use in wiring telephone, telegraph, annunciator, bell and in fact all battery circuits. The special features are that the fibre forms a good insulating and mechanical protection, preventing the metal of the staples from coming in contact with and damaging the insulation of the wiring and causing short-circuits. The fibre is securely at-

STAPLES.

tached so that it cannot come off in driving, and the staple is provided with flat head, substantial shanks and sharp points, giving excellent driving qualities.

The cost of such a staple is less than the screws alone used in cleat work and the insulating and mechanical protection is claimed to be just as good. Wiring can be properly done much more quickly with these insulated staples than with either bare staples or cleats, causing a considerable saving in labor, and giving a neater and more efficient and better job. The staple shown is made by the Blake Signal & Manufacturing Company, 246 Summer Street, Boston.

Compound Starting and Regulating Rheostat.

The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., has recently placed upon the market a new type of compound starting and regulating rheostat, intended principally for use in connection with motors operating machine tools or similar apparatus where the motor is brought from rest to normal full speed in the usual starting period, and the speed regulation of the motor is effected entirely by means of the shunt field control. The objects sought in the design of these controllers were the provision of a large number of field regulating stops, the elimination of the possibility of starting the motor under a weakened field, operation by

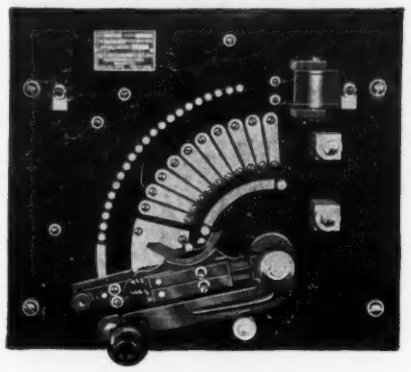


FIG. I.—RHEOSTAT.

means of a single lever in a simple and natural manner, and the returning of all parts to the starting position automatically under conditions necessitating this action.

The apparatus consists of a motor-starter of approximately standard construction, and a series of field buttons controlled by a field resistance lever mounted on the same hub post as the starter lever and co-operating therewith. The face of the apparatus is shown in the two accompanying figures.

In operation the motor is started and brought to speed by moving the handle to the right, this handle being attached to the field regulator, which is mechanically connected to the starter lever so as to move them as one piece in starting the motor. During this operation of starting the field resistance is short-circuited by an auxiliary contact mounted on the starter lever and a curved sector located

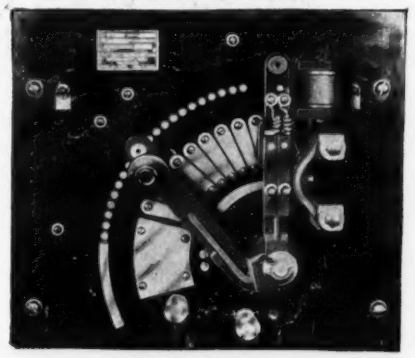


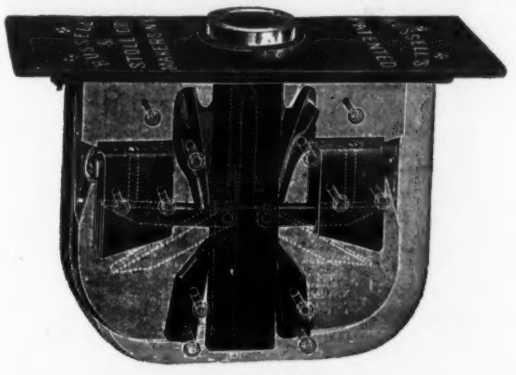
FIG. 2.—RHEOSTAT.

just below the armature contacts. When the two levers have been moved to the position in which all resistance is cut out of the armature circuit, a keeper on the starter lever is attracted by the retaining magnet, and the starter lever is held in this position. At this time also the auxiliary contact above referred to has left the curved sector, thus removing the short-circuit from the field resistance. The field lever is now free for movement over the field rheostat buttons at the will of the operator, and may be left at any desired point, thus regulating the speed of the motor as desired. If the retaining magnet is de-energized either by failure of voltage or by the operation of overload release devices, the starter lever is released and returns to the starting position, carrying with it the field rheostat lever.

This type is especially adapted for use where the apparatus is within reach of the machine attendant. The instrument is usually mounted upon the machine tool whose motor it is intended to control. Machine operators who have thoroughly tested and examined the apparatus under consideration have reported excellent results from its use.

Stage Receptacle.

The "Russell Quick-Break Pocket" or receptacle and plug shown herewith has been designed to meet the severe requirements of stage receptacle work, where 25 amp. or more are taken from an outlet. Tthe body part of this fitting is made of two very heavy blocks of porcelain bolted together, and the inner surfaces of the porcelain blocks carry contact plates to which the feeding wires are attached by terminal screws at each side of the box. The porcelains have a center opening or throat from top to bottom and directly between the contact plates, to receive the extension circuit plug. The plug is arranged with hinged contact arms, and when pushed into the throat



STAGE RECEPTACLE.

of the box these arms are thrown out and into contact with the terminals of the box. It will be seen from the cut that the box terminals are widely separated, and well away from the plug throat, so that when the plug is removed and the opening left open, any foreign matter falling into the throat can go on through and cannot come in contact with the live parts. It will be seen that these fittings are a departure in design and construction from former devices of the kind. They are made by Russell & Stoll Company, of 48 Cliff Street, New York.

Ammeter for Induction Coil Secondary.

The Röntgen Manufacturing Company, of Philadelphia, has developed a milliampere meter of the D'Arsonval type which measures accurately the current in the secondary spark of a Ruhmkorff induction coil. In Röntgen-ray work this meter makes possible the comparison of dosage of rays given to patients, for it has been found that the quantity of radiation is proportional to the current which produces them. It is readily understood that the use of such an instrument makes possible the establishment of a strictly scientific method of the standardization of dosage, so that the different workers may accurately compare their results. The meter is readily adapted to any make of coil or static machine since its indications are correct for both static machines and coils.

Perhaps the most remarkable thing noticed by the operator of a coil when he uses one of these meters for the first is the very small value of the current. It is only milliamperes, and when readings are taken of the output of static machines and coils with various makes and resistances of Röntgen-ray tubes, many curious and interesting facts are developed. One very evident thing is the great amount of current which a soft tube takes as compared with that taken by a hard one. For instance, on the average 10-in. coil a tube having an equivalent spark resistance of 3½ in. of air will take but about 1 milliampere of current; but the same tube on the same coil will easily take 2 milliamperes when the tube resistance has been lowered to about 2 in. of spark resistance of air. Readings taken from static machines show that their output is very much less than that of coils, as long has been considered. The average 12 revolving glass plate static machine gives a maximum of about 8/10 of a milliampere.

The meter is a D'Arsonval system adapted to high voltages. In its use only the unidirectional impulses from the induction coil are permitted to flow in the secondary circuit, for if the "inverse discharge," so-called, is allowed to pass, the reading of the meter is the algebraic sum of the integrated positive and negative currents.

The adaptation to the high voltage is simple and novel. The meter case and permanent magnet system are both grounded to one

side of the moving coil and its shunt, thus causing the only difference of potential between the case of the instrument and its contents to be the drop in potential through the two coils. The difference of potential due to the self-induction of the moving coil is enough to cause sparking between its turns and from the coil to adjacent parts, were it not shunted by a small mica condenser which is of the correct value to neutralize the self-inductive effect of the moving coil. The drop through the moving coil is thus made to be approximately equal to its ohmic drop and the only difference of potential between the parts of the meter is the difference due to the ohmic fall of potential in its coils.

INDUCTION COIL AMMETER.

The entire meter is supported upon an insulating standard, and the meter case with all its contents rises and falls in potential with the varying potential of the high-tension circuit, so that it is charged when the secondary wires are charged and sparks may be obtained from the outside of the meter just as easily as from the secondary wires of the coil, although this is productive of no harm to the meter.

Some New Electrical Measuring Instruments.

The Willyoung & Gibson Company has recently extended considerably its line of instruments of precision, and we illustrate herewith several of the new additions.

Fig. 1 shows the Willyoung-Dolezalek electrometer removed from its case. The needle of this instrument is extremely light and moves within very small quadrants, each of which adjusts independently.

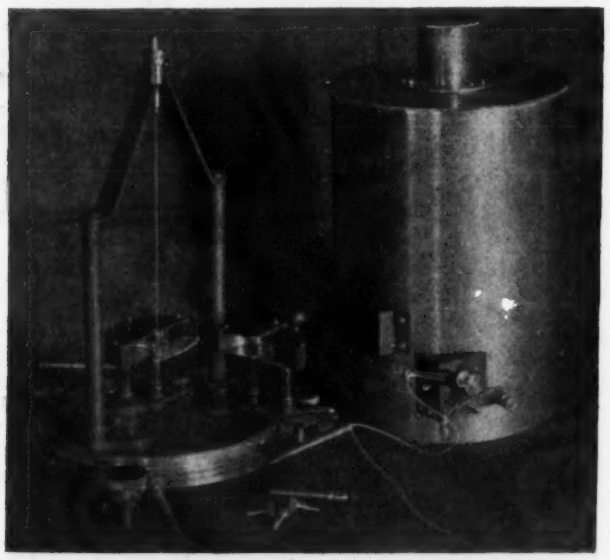


FIG. 1.—WILLYOUNG-DOLEZALEK ELECTROMETER.

The quadrants are hinged in pairs, thus swinging out and giving great accessibility. The needle is suspended by quartz fibre and charged by an exterior key. This instrument is so sensitive as to give 1,000 to 1,200 scale divisions with 300 volts on the needle and a difference of one volt between the quadrants. This corresponds to measuring the current of about 3×10^{-14} amp. Owing to the lightness of the needle, it is also very dead-beat. This instrument has many uses, but above all is adapted for making measurements of radioactive phenomena.

Fig. 2 illustrates a standard potentiometer, direct reading by 0.001 of a volt from zero to 1.5 volts. The instrument is of the high-resistance type and on the Varley slide plan, and is complete with its own regulating coils, switches, etc. With the volt box of Fig. 3 the range of the instrument is extended to 1,500 volts. This instrument

FIG. 2.—STANDARD POTENTIOMETER.

has been furnished such institutions as Georgia School of Technology, University of Tennessee, etc., as well as a number of industrial plants, and is recommended by the makers as a practical all-

FIG. 3.—POTENTIOMETER.

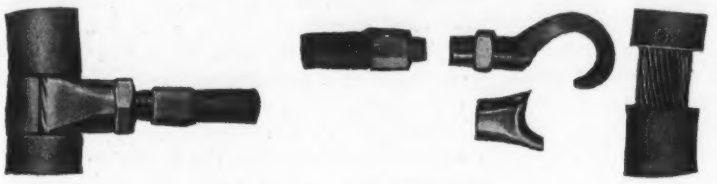
around instrument for calibration of ammeters, voltmeters, etc. Besides this particular potentiometer several other forms of a greater or less degree of refinement are made.

Dossert Tap Joint.

To meet the demand for a cable tap joint which may be applied in high-tension work when the service is live, in which cases the live contact should be handled as little as possible and a quick application is particularly valuable, Dossert & Co., 59 Fulton Street, New York, have developed the tap joint illustrated herewith. The assembly of the joint is indicated in Fig. 1, and in Fig. 2 the various parts are shown.

A massive cast copper hook carefully machined to fit the cable forms the main member of the joint. The shank of this hook is threaded and drilled so as to form a nipple for the standard Dossert joint of the desired size. Upon this shank is secured also a heavy compression nut, which presses upon a suitably shaped casting fitting in the space between the cable and the base of the hook and forcing

it against the cable with a pressure of several tons. The contact area of the hook contact is a carefully machined surface of many times the area of the cable that it surrounds, the portions being adjusted to fit the size of the tap. In mechanical strength and electrical con-



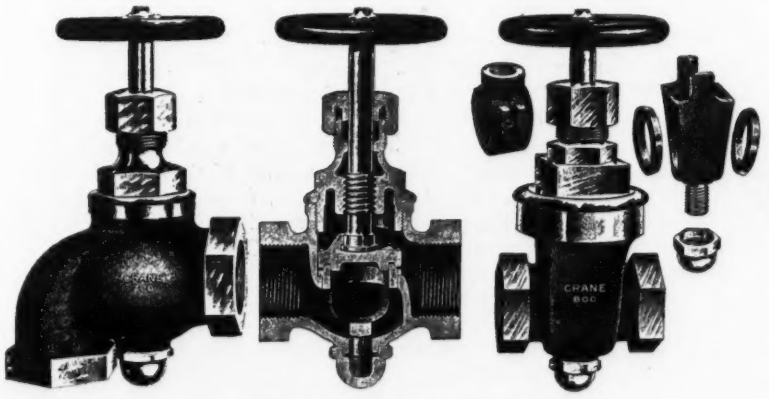
FIGS. 1 AND 2.—CABLE JOINT.

ductivity, this tap joint is always superior to the tap wire which it serves to connect.

In applying the joint, the tap wire may be fastened to the hook by a coupler provided for that purpose. The main cable is then bared exactly the width of the hook and scraped clean. The hook is then fastened over the wire and the lower casting is slipped in place. This lower casting is so shaped that it is impossible to adjust it in any but the correct position. The tightening of the compression nut finishes the work, which may then be taped up and will be found to be less bulky and more conducting than any equivalent soldered joint.

Crane Valves.

We illustrate herewith several improved forms of valves being put on the market by the Crane Company, of Chicago. Figs. 1 and 2 show an improved renewable seat and disc globe or angle valve. These valves are suitable for working pressures up to 250 pounds and are tested to 700 pounds pressure per square inch. As the accompanying cuts indicate, they are a decided improvement over former types and embody several new and important features in their construction. The renewable parts are made of hard and superior composition, far better than the usual composition put into valves and last many times longer than those in the ordinary valves. They are especially suitable for any hard work, where extreme



FIGS. 1, 2 AND 3.—VALVES.

pressure is used and where the wear and tear on the valve is most severe.

By unscrewing the nut on the bottom of the valve all parts are accessible and removable from the top, thus making it convenient to substitute a new seat or new disc when required, or to replace any worn part. The disc being attached to the stem by a slot is easily removed and replaced. The seat and disc can be removed and the two ground together if necessary. In puttng the valve together, after replacing the seat, the nut is tightened on the bottom of the valve, which holds the seat in place, after which the bonnet is screwed on. The construction of these valves is such that they may be packed when open without steam escaping, which is done when the valve is wide open.

The Crane patent renewable seats and wedge straightway valves, shown in Fig. 3, are made with copper seats and hard metal wedge. They are suitable for working pressures up to 250 pounds and are tested to 800 pounds pressure per square inch. The ready method of inserting these renewable parts and the wide range in the use of these valves and for all kinds of severe service recommend them to all who require thoroughly reliable fittings.

The Crane "self-packing" globe and angle and radiator valves are made with Jenkins disc and non-rising stem and satisfactorily supply a demand for valves embodying this very desirable self-packing feature. In this valve a piece of vulcanized rubber is introduced between the two metallic parts, which makes a perfect seat and from large experience with these valves in actual service this device has completely overcome the tendency to leak; in fact, where used under the most severe conditions, entirely satisfactory results have been obtained. In any event, should these valves become leaky, a new vulcanized rubber disc can readily be inserted.

Automobile Speed Indicator and Counter.

The Warner Instrument Company, of Beloit, Wis., is placing on the market an appliance for automobiles known as the "Auto-Meter," which is a combination of speed meter and odometer, with trip and season dials, and records both the distance traveled and the speed of traveling. It operates on the Arago disc principle, the revolving part being a magnet which exerts a drag on an indicating disc. The magnet revolves freely on ball bearings. The indicating dial is suspended in front of the magnet and a partition separates them, precluding the possibility of air affecting it. The dial is mounted on a pivot, the ends of which ride in sapphire bearings.

A hairspring holds the dial to zero point. The magnet when re-

FIG. 1.—AUTOMOBILE SPEED INDICATOR.

volving has a tendency to draw the dial in the direction of its revolution, and the hairspring opposes this tendency. The greater the rapidity of the magnet's revolution, the greater the displacement of the dial, the displacement increasing proportionately as the speed increases, so that an even reading over the entire range of scale results. The length of the dial is practically six inches—remarkably large for so small an instrument. The action of the magnet on the dial being direct, there is nothing intervening to cause a variation in its reading. A worm driven by the same flexible shaft which drives the magnet operates a worm gear which is connected directly to the odometer. Driving the odometer in this manner obviates

the danger of knocking it off, which is likely to occur were it mounted on the axle. Mounted on the dashboard where it can be tilted to any angle to accommodate the vision of the motorist, it is possible for him to determine the distance covered at any stage of the journey.

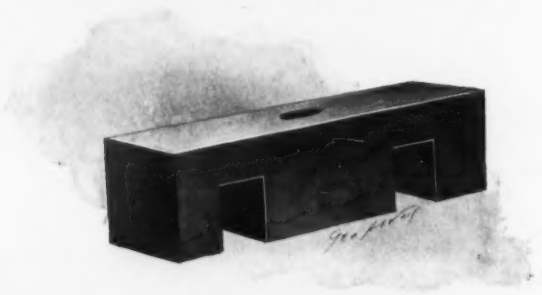
The internal parts of the "Auto-Meter" are gold-plated, not to please the eye of the user—for he never sets eye on these parts—

FIG. 2.—AUTOMOBILE SPEED INDICATOR.

but to add to their durability. The ball cups and cones are carefully made from the best steel and thoroughly tested before used. To make assurance doubly sure, the instrument is tightly sealed and becomes absolutely dust-proof. The "Auto-Meter" will show accurately a speed of one mile per hour. When properly installed on the car the needle stands perfectly steady from minimum to maximum speed and regardless of how much the car may sway.

Hard Fibre Cleats.

Cleats made of hard fibre were originally designed for telephone wiring only, but the demand for other uses has led the Morris Electric Company, of Wilmington, Del., to extend the line until now it includes types for the most various electrical work. The hard fibre cleat is now being used extensively for bell and annunciator wiring, time clocks, telegraphic purposes and by gasoline engine, automobile



HARD FIBRE CLEAT.

and storage battery manufacturers for fastening wires to metal or slate. For the last-mentioned uses it replaces metal cleats, which in time injure the insulation of wire. The largest size of cleat now made is shown herewith, and is used for fastening wires to electric light switchboards, motor frames, starting panels, controllers, etc. The cleats are made in red, gray and black, and for a single wire, two or three wires.

Battery Connector.

A new battery connector and terminal has been placed on the market by the Eastern Carbon Works, of Jersey City, N. J. At first sight, the connector is the least expensive of any part of a costly installation, yet experience has shown that on all work where there is the slightest vibration the ordinary connection causes more trouble proportionately than any other part of the installation, by its tendency to shake loose, thereby breaking the circuit.

The construction of the new terminal makes the loosening of the nut impossible, as a glance at the accompanying illustration will

BATTERY CONNECTOR.

readily show. The rubber, under pressure of the nut against the metal blank to which it is secured, is compressed, thereby creating a pressure of the nut with the threads of the engaging screw of considerable force, which no amount of vibration can overcome. It is particularly adapted for service on automobiles, motor cycles, launches or any place where the jolting and vibration is excessive.

Equipment for Animas Power Plant.

The Animas Canal Reservoir Water Power & Investment Co.'s hydro-electric plant to be constructed on the Animas River in the vicinity of Rockwood, Colo., is to be installed with 8,000 hp of equipment, comprising two 4,000-hp water wheels, built by the Pelton Water Wheel Company, and direct-connected to General Electric generators of 2,250-kw capacity each. The Pelton people have also taken the contract for the pipe line material, consisting of some 2,500 feet of 34-in., 36-in., 40-in. and 44-in. pipe. The plant will be so constructed as to permit of the installation of two other units of similar capacity. The company, of which Mr. H. T. Henderson, of Durango, Colo., is president and chief engineer, while Mr. F. O. Blackwell acts as consulting expert, plans the ultimate development of nearly 40,000 hp in all by utilizing the energy to be generated by three plants on the Animas River. The current will be used principally for operating mines and for lighting purposes. The Animas River is the largest stream in the southwestern section of Colorado. Between Silverton and Durango it has a fall of nearly 3,000 feet, most of which is confined to some twenty miles of the river. The company has acquired all rights of the waters, from its upper dam, ten miles below Silverton, to a point sixteen miles above Durango. The right to the waters of Cascade and Lime Creeks is also in the hands of the Animas Company. In the first instance, 104 miles of power transmission will be constructed. The energy will be carried to Durango, about twenty miles south of the power house. Another line is to be built to Silverton, twenty-five miles to the north. Camp Bird will also be supplied from the initial plant, also several silver, lead and gold mines in the San Juan district. Current will be transmitted at 50,000 volts. The company expects to have the first plant in operation by June 1.

25,000-HP. California Project.

The Central California Electric Co. will construct a 25,000-hp hydroelectric plant on the banks of the American River, at Alta Station, located sixty miles from Sacramento. The water, after passing the present pumping station at Alta, will be conveyed by means of a short canal to a point where a drop of no less than 2,100 feet can be obtained. The Platt Iron Works, of Dayton, Ohio, will design the hydraulic machinery. Four direct-connected water turbines of about 6,500-hp capacity each will be installed. These machines will be arranged for direct connection to polyphase generators operating at 750 r.p.m. Preliminary surveys for the new plant are now under way. The Central California Electric Company interests at present operates three power plants, which generate current for transmission to Sacramento, Grass Valley and other cities.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—Business conditions were rather quiet owing to the holidays. Inventories and preparations for annual settlements monopolized attention, excepting in some branches of manufacture, where immediate deliveries were required. Industry is of notably large volume for this season of the year, especially in iron and steel and kindred lines of manufacture. The cotton goods manufacturing trade has, however, been again unsettled by the slump in cotton to below alleged cost of production, and Southern trade has been depressed in tone thereby. Other developments have been largely favorable. There have been distinct gains in certain staple articles, notably in values of copper, and especially in Southern pig iron, with a general strengthening of the lines in every department of the metal trade. Iron, copper, spelter and lead closed the year at the highest prices established during the season. The copper market was quiet and unchanged during the week. Consumers are inactive and the demand from the interior is slow. Lake is quoted at 14⅞ to 15⅛; electrolytic, 14¾ to 15⅛; casting stock, 14½ to 14⅞. Collections show some effect from the recent heavy circulation of money in retail lines, in enlarged receipts. Annual reviews indicate that the year has made a much better showing than seemed possible at the outset, the second half comparing very favorably with the first six months, and the amount of business on the books in the leading industries promises still further improvement in 1905. Commercial failures for the week ending December 29, as reported by *Bradstreet's*, numbered 218, against 240 the previous week and 209 the corresponding week last year.

SOME RIDGWAY DYNAMO AND ENGINE ORDERS.—McClave, Rimmer & Co. (formerly McClave, Hamilton & Co.), Singer Building, sales agents for the Ridgway (Pa.) Dynamo & Engine Company, reports receipt of orders this month which represent in the aggregate the best month's business of the year. The list includes a contract secured from the Waiontha Knitting Company, of Richfield Springs, N. Y., for a 100-hp Ridgway simple automatic engine, arranged for direct connection to a 250-volt, 275 r.p.m. Thompson-Ryan generator. Seven semi-inclosed Sprague motors, ranging in capacity from 2 hp to 20 hp, and from 1,200 r.p.m. to 1,000 r.p.m., will also be put in. Two 125-hp Ridgway simple automatic engines direct connected to 75-kw Fort Wayne generators, 125-volt, 275 r.p.m. machines, have been ordered by Thompson & Bonney, of Brooklyn, the contractors for the Brooklyn Bridge lighting plant. An 85-hp Ridgway simple automatic engine, to be direct connected to a Sprague 250-volt, 280-r.p.m. generator of 50-kw capacity, is to be used for power purposes by Mr. George Kern, the wholesale butcher, Thirty-eighth Street and Ninth Avenue. The Hotel Florence is to have a lighting plant consisting of a Ridgway simple automatic engine of 125 hp capacity, which will be direct connected to a 125-volt, 275 r.p.m. Thompson-Ryan generator. Another order calls for a 160-hp Ridgway simple automatic engine arranged for direct connection to a Thompson-Ryan 250-r.p.m., 120-volt generator of 100 kw capacity. This outfit is intended for furnishing light in the silk mills of J. Hall & Co., Paterson, N. J.

MANUFACTURE EXPORTS.—Exports of manufactures in the calendar year 1904 will probably exceed $500,000,000 in value. Details of 11 months' exports just completed by the Department of Commerce and Labor show for the 11 months of the present year a total of $459,575,023 of manufactures exported and for the month of November alone $46,608,896, so that unless December exports should prove much less than those of November the total exports of manufactures for the calendar year must exceed $500,000,000. The following table shows the exports of manufactures in each calendar year from 1894 to 1904 (December, 1904, being estimated):

1894	$177,800,969	1900	$441,406,942
1895	201,152,771	1901	395,144,030
1896	253,681,541	1902	410,650,967
1897	279,616,898	1903	421,453,915
1898	307,924,994	1904	500,000,000
1899	380,787,891		

The exports of manufactured goods will therefore be three times as great in 1904 as ten years ago in 1894.

EQUIPMENT FOR D. L. & W. SHOPS.—The contract has been let for the electric equipment to be installed in the Kingsland (N. Y.) shops of the Delaware Lackawanna & Western Railroad to the Crocker-Wheeler Company, through its New York offices, Mr. F. B. DeGress, manager. The Brown-Boveri alternating current machinery will be put in. The equipment will be built at the Ampere (N. J.) shops. There will be one 300 kw. engine type, 240 volt, 225 r.p.m. generator; one of 200 kw. capacity; one 30 kw. engine-driven exciter; one 30 kw. motor-driven exciter set and one 80 kw. generator set. The engines will be built by the Buckeye Engine Company, of Salem, O. Provision is made for the installation of a 300 kw. generator later on. The Crocker-Wheeler people have also taken the contract for the complete switchboard and the arc lighting system for the Kingsland shops. There will be 250 arcs.

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph Company instrument statement for the month ended November 30, and since December 31, compares as follows:

	1904.	1903.	1902.	1901.
Gross output	103,922	96,963	93,487	88,497
Returned	39,934	32,297	36,838	27,510
Net output	63,988	64,666	56,649	60,987
Since Dec. 31, 1903 and 1902, and Dec. 20 in previous years:				
Gross output	1,094,291	1,020,941	994,422	867,323
Returned	465,631	441,013	420,682	352,173
Net output	628,660	579,928	573,740	315,150
Total outstanding	4,408,177	3,730,248	3,099,346	2,467,968

TELEPHONES FOR BRAZIL.—The International Telephone Manufacturing Company, Chicago, closed its year's business with an export shipment of the largest magneto multiple self-restoring drop switchboard ever built in the telephone field. The equipment consists of a 4,200-line capacity exchange, including all the central office apparatus, and is for re-equipping the public service exchange of the Comp. Telephonica do Estado de S. Paul, of Sao Paulo, Brazil. The apparatus embodies in its construction many new features, and is made up with the highest class of workmanship throughout. It should help divert the South American trade in this line to the United States.

FIRE ALARM CABLES.—It is understood that the Borough of Manhattan fire alarm department is calling for bids for two cables to be attached to the elevated structure of the Interborough Railroad Company on Second and Ninth Avenues; one extending from South Ferry to Fifty-ninth Street, on Ninth Avenue, and the other from South Ferry to Hanover Square on the Second Avenue line. The cables are to be supported by Boston clips and are to connect also with the underground system. Each cable is to contain 20 pairs of rubber insulated No. 16 B. & S. copper wires. The supporting cable is to be 5/16 galvanized stranded steel. Some 19 cable boxes will be required.

PLANT ORDERED FOR GRAMATAN INN.—The plant to be installed in the Gramatan Inn, Lawrence Park, Bronxville, N. Y., will comprise one 160-hp Ridgway simple automatic engine and two of 85-hp capacity each, arranged for direct connection to General Electric generators. The larger engine will have a 100-kw, 125-volt, 250-r.p.m. generator, while the smaller machines will be direct connected to 50-kw, 275-r.p.m. generators. Pattison Brothers, Flat Iron Building, are the engineers for this work.

ALLIS-CHALMERS-BULLOCK ORDER.—The New Jersey Zinc Company (New York offices Empire Building) has awarded the contract for the complete equipment of its new Depew (Ill.) plant to the Allis-Chalmers Company. There will be two 500-kw. 250-volt engine-type generators, direct-connected to engines. The contract also calls for a 100 kw. high-speed unit and 15 motors, ranging in capacity from 5-hp to 75-hp.

MORE EQUIPMENT FOR BAUGH PLANT.—The Baugh Chemical Company, of Baltimore, Md., is to install additional electrical equipment in its plant. Mackenzie, Quarrier & Ferguson, 114 Liberty Street, have received an order for a small generating set, which will consist of a Harrisburg-Fleming side crank engine, direct-connected to a General Electric generator.

EQUIPMENT FOR BERKSHIRE PLANT.—The Berkshire Power Company, of Hartford, Conn., of which Mr. W. R. C. Corson is the engineering expert, has awarded the contract for the initial electrical equipment to go in its water power plant to the Westinghouse Electric & Manufacturing Company. The contract calls for two units of 300-kw. capacity each.

AFTER MEXICAN WATER POWER.—Mexican advices state that Mr. H. W. Campbell, of Portland, Ore., who is general manager of the Columbia River & Northern Railway and the Regular Line of Steamships, is in the Southern republic with a view to securing a concession for an extensive water-power scheme. No details are yet to hand.

SOME C & C ORDERS.—The C & C Electric Company, 143 Liberty Street, advise that the orders secured during the past month exceed in volume all business received for any month for the past two years at least. There is a particularly strong demand at present for motors for driving fans, etc. Three 12-hp special slow speed motors have been ordered by Rossman & Bracken, the ventilating apparatus contractors for the new Harlem Hospital at 136th Street and Lenox Avenue. These motors will operate Baldwin fans. The Davies & Thomas Company, of Catasaugua, Pa., has ordered an 80-hp, 220-volt, slow-speed C & C motor for driving a blower. The Christ Church Memorial, New York City, is to be installed with two slow-speed special motors for driving blowers. Several motors have been requisitioned for the new Henry Heide candy factory, Vandam and Hudson streets. Five special slow-speed motors, 230-volt, ranging from 1 hp to 10 hp, have been ordered for driving American Blower Company fans in the Gouverneur Hospital, New York City. The Grasselli Chemical Company, of Cleveland, Ohio, has ordered for its Grasselli, Ohio, plant three 15-hp and a similar number of 25-hp open-belted, 220-volt, slow-speed motors. William Wharton, Jr., & Co., of Philadelphia, have ordered a 75-kw, 250-volt, 275-r.p.m. generator, to be arranged for direct connection to a Watertown, N. Y., engine for installation in their steel plant, where the outfit will be used for power purposes. Six 30-hp, 500-volt, 800-r.p.m. inclosed type crane motors have been requisitioned for use in one of the large Indiana quarries. The Robert H. Foerderer Company, of Philadelphia, is to be shipped a 150-kw, 125-volt, 180-r.p.m. generator to be direct connected to an Erie City Iron Works four-valve engine. Mr. David Miller has ordered for his 103d Street stone yards a 125-kw belted generator for power purposes.

NEW NIAGARA TURBINES.—A special telegram from Niagara Falls, of January 2, says: "The Canadian Niagara Falls Power Company, the ally of the Niagara Falls Power Company on the American side of the river, set in motion to-day two of their 10,000-hp turbines. The officers of the power company, the commissioners of the Niagara Falls Queen Victoria Park, and other guests were witnesses. The trial was a great success. These are the largest working turbines and dynamos in the world, and their successful operation marks an important era in electrical development. Francis Lynde Stetson, of New York, and President W. H. Beatty, of the Canadian company, turned on the power, and each unit under full power developed 12,000 volts, and ran without a hitch. After the test a luncheon was served at the Hospice of Mount Carmel on the high bluff of the Niagara. The guests, including Mr. Stetson, made congratulatory speeches, and the names of King Edward and President Roosevelt were heartily cheered."

LOWER TELEPHONE RATES.—The reduction in the telephone rates by the New England Telephone & Telegraph Company in Boston, where it has no opposition, has raised the question as to the purpose and expediency of such a policy. An official of the company says: "The main reason for reducing the telephone rate from 10 cents to 5 cents in the exchanges of Boston proper was to popularize the telephone. With this reduction it is our expectation to place an increased number of telephones in the smaller mercantile houses, the nickel-in-the-slot machine being the form of telephone to be generally installed. As the area affected by the reduction includes a large residential section, especially the Back Bay, it is anticipated many additional home telephones will be installed. For a short time the company will, of course, suffer a loss in revenue by the reduction, but this loss will be far more than made up in a short time by the increased use of the telephone."

EQUIPMENT FOR NEW YORK CENTRAL.—The New York Central & Hudson River Railroad Company's tunnel power houses at Yonkers and Port Morris, each of which are to be installed with four 5,000-kw Curtis turbines, will also be equipped with Worthington centrifugal pumps to be utilized for circulating water for the Worthington condensing apparatus to be put in. These pumps will be operated by eight 150-hp engines, four for each station. The engine contract was secured by the engineering and contracting firm of Mackenzie, Quarrier & Ferguson, 114 Liberty Street. The engines will be of Harrisburg-Fleming side crank build.

EQUIPMENT FOR NEW HIPPODROME.—The new hippodrome under construction at Forty-fourth Street and Sixth Avenue by the Thompson & Dundy interests will take all its electric service from the New York Edison Company. The L. H. Prentice Company, of 114 Liberty Street, has secured the contract for the heating and ventilating system to be installed. There will be four 25-hp C & C, 230-volt, slow-speed motors for driving the blowers. One 40-hp C & C and two 20-hp slow-speed motors will also be employed to drive pumps being built at the Morris Machine Works, Baldwinsville, N. Y., for the same amusement resort.

HYDRO-ELECTRIC PLANT FOR VENEZUELA.—The Federal Electric Company, Washington Life Building, recently obtained a contract for the complete equipment of a good-sized hydro-electric plant in the mountainous regions in Venezuela. The contract also calls for about two miles of 70-inch pipe line. The machinery will be built so as to permit of its transportation by mules. A power transmission system some 40 miles in length will be constructed to carry the power to various villages for lighting purposes principally.

MORE CURTIS TURBINES FOR JAPAN.—The capacity of the Yokohama Electric Light Company is to be added to. A 500-kw Curtis turbine has been ordered from the General Electric Company through Mitsui & Co. A turbine of similar build and size has also been ordered by the Mitsui people for installation in the power plant of the Oji paper mills, among the most extensive concerns of their description in the Far East.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, Chicago, has recently secured some large contracts for additional equipment to be used in extending the public service municipal telephone exchanges at Port Arthur, Ont., and Fort William, Ont., Canada, and also for additional telephones for the municipal public service exchange at Neepawa, Manitoba, Canada.

EQUIPMENT FOR LEHIGH VALLEY MINES.—The Lehigh Valley Coal Company has just awarded a contract for the electrical equipment of its Hazeleton, Pa., shaft. There will be a 330-hp Ridgway simple automatic engine to be direct connected to a 150-kw, 220-volt, 200-r.p.m. Westinghouse generator. Three Westinghouse Baldwin electric mine locomotives have also been ordered.

EQUIPMENT FOR FORDHAM HOSPITAL.—Contracts have been given out for the equipment to be installed in the new Fordham, N. Y., hospital. Mr. Fred Pearce, of 18 Rose Street, has taken the contract for the engine and generator, and the Northern Electric Manufacturing Company, of Madison, Wis., New York offices, Columbia Building, will build the motors.

EQUIPMENT FOR SINGER PLANT.—Contracts are about to be placed for equipment to be put in the Elizabethport plant of the Singer Manufacturing Company. C. W. Hunt & Company are the consulting engineers on the work. The equipment will comprise two 100-kw generators arranged for direct connection to engines of 150-hp capacity each.

EQUIPMENT FOR BOWERY BAY.—The Bowery Bay Building & Improvement Company, Steinway Building, Fourteenth Street, is about to increase the capacity of its power plant at North Beach by installing two 500-hp Williams vertical cross-compound engines arranged for direct connection to Stanley generators.

TO LIGHT MEXICAN SUGAR PLANTATION.—The Mexican Plantation Company, whose head offices are at La Crosse, Wis., has let an order for a small plant to be shipped for lighting its sugar mill, etc., at Tolosa, Mexico. The dynamo will be of C & C build, and the engine will be a Sturtevant machine.

EQUIPMENT FOR GOUBERT PLANT.—The Goubert Manufacturing Company's projected plant at Bayonne, N. J., will have an electrical equipment of about 250-kw capacity, plans for which are now being drawn up. Mr. W. T. Rowley, secretary and treasurer of the company, has charge of the matter.

MORE EQUIPMENT FOR MEAT PLANT.—The United Dressed Beef Company, Forty-third Street and First Avenue, New York City, has placed a contract with the Crocker-Wheeler Company for two 150-kw three-bearing, 125 volt, 375 r.p.m. belted generators, for installation in its packing plant.

TELEPHONES IN HOTELS.—The Hotel Willard, Washington, D. C., has placed a contract with the Chesapeake & Potomac Telephone Company for the installation of 400 long distance telephones. The instruments will be placed in all of the rooms and working departments of the hotel.

MORE EQUIPMENT FOR GENERAL CHEMICAL.—The General Chemical Company, of 25 Broad Street, New York City, has decided to put in additional electrical equipment in its Bayonne factory. Mr. William Crocker, the company's engineer, has the matter in hand.

PLANT FOR ORPHAN ASYLUM.—An isolated plant is to be installed at the Colored Orphan Asylum to be built on the Hudson River at Riverdale, N. Y., by the Colored Orphan Asylum Association for the benefit of colored children, West 143d Street, near Broadway.

EQUIPMENT FOR JAPANESE STEEL PLANT.—The big Sumitomo steel casting plant at Kobe will shortly be equipped with further electrical machinery of American build. There will be quite a number of large electrical operated machine tools, etc., put in.

ENGLISH MAXIM COMPANY.—At a meeting of the shareholders in the Hiram Maxim Electrical Engineering Company it was stated that the present difficulties of the company were due to want of capital. A scheme of reconstruction is in contemplation.

LIGHTING SUPPLIES FOR MEXICO.—The export firm of Carr Brothers, of 32 Broadway, has secured a substantial contract for arc lamps, sockets, cut outs, wire, etc., for shipment to Mexico.

ELECTRIC PLANT FOR JAPANESE COAL MINES.—A contract is about to be let in this market for electrical equipment to be installed in one of the larger Japanese coal mines. The initial capacity of the plant will be 250 kw. The generator will be a three-phase alternator, 60 cycle, 600 volt. There will also be seven motors ordered—three-phase induction type—three of 5 hp, two of 10 hp, one of 25 hp, and another of 75 hp capacity. The motors will be used for driving centrifugal and sucking pumps, and for operating winches. Mr. Francis A. Cundill, of 90-96 Wall Street, who represents the interests of the British electrical engineering and contracting firm of L. J. Healing & Co., of Yokohama, on this side, is getting estimates. Mr. Cundill is shipping considerable quantities for electrical supplies, etc., to the Far East at present. He has an order in hand for some 150,000 feet of insulated wire.

SOME CROCKER-WHEELER ORDERS.—The Crocker-Wheeler Company, through its New York offices, reports receipt within the past few days of an order for two 90-hp shunt-wound motors for shipment to the Trenton plant of John A. Roebling's Sons Company. Several motors, ranging in size from 1 hp to 7 hp, have been requisitioned by the Bridgeport (Conn.) Safety Emery Wheel Company. They will be used for operating grinders. The Gloversville (N. Y.) Knitting Company has ordered a 65-kw. two-phase, 240-volt belt type alternating-current generator, with exciter and switchboard complete. Another Crocker-Wheeler order calls for a 50-kw. engine type, 240-volt generator, for installation in the Consolidated Safety Pin Company's plant at Bloomfield, N. J.

A. E. HOLADAY MANUFACTURING COMPANY.—At New Haven, Conn., Judge James P. Platt, in the United States District Court, has appointed Attorney Harry W. Asher receiver for the A. E. Holaday Manufacturing Company of that city, which has been forced into bankruptcy upon the petition of creditors. The concern manufactures electrical supplies. The company was incorporated in 1902. The schedule shows that the assets are between $1,500 and $2,000 and that the liabilities are $10,000.

BIG MEXICAN HYDRO-ELECTRIC PROJECT.—Mr. David Reyes Retana of Mexico City is primarily interested in a concession which is being negotiated for with the Mexican Government looking to the establishment of a large hydro-electric installation on the River Mexcala, State of Guerrero. It is proposed to use no less than 60,000 liters of water per second. Half the power is intended for lighting and manufacturing purposes and the rest for irrigation.

PLANT TO OPERATE MEXICAN SUGAR MILLS.—The construction of a fair-sized water-power plant is projected by the Rio Tonto Sugar & Cattle Company on the River Tamosopo, district of Ciudad del Maiz, State of San Luis Potosi, Mexico. The energy generated will be utilized for the purpose of operating sugar mills, etc. The necessary permission to erect the plant is being sought from the Mexican authorities.

TELPHERAGE SYSTEM FOR INDIA.—The East Indian Railway authorities contemplate the erection of a somewhat extensive system of electric telpherage at their big new riverside freight warehouses at Howrah.

ELECTRIC LOCOMOTIVES FOR JAPAN.—Inquiries are being made here for electric locomotives to be used on a new Southern railway in Japan. Each locomotive will have a cab with a capacity for 15 passengers.

ERIE RAILROAD POWER PLANT.—The Erie Road will spend over $8,000,000 on a new station and power house in Jersey City, for which plans have already been prepared.

Financial Intelligence.

THE WEEK IN WALL STREET.—Stock values have improved, and speculation was more active under bullish manipulation, attended by indications of investment-buying in anticipation of the January interest and dividend disbursements. The Steel stocks and standard railroad shares led the movement, bonds being also very strong. Other industrial stocks improved in sympathy, and Amalgamated Copper was responsive to an improvement in copper prices, but broke on Friday afternoon under renewed bearish pressure. Greater firmness was shown in traction and electric securities, and there was a good business done. Brooklyn Rapid Transit closed at 61¼—a net gain of 1⅛. Metropolitan Street Railway made a net gain of ½-point, closing at 120½, and Interborough Rapid Transit closed at 164. Allis-Chalmers preferred made the record gain for the week among the industrials, the net being 7½ points and the closing quotation 69½; common closed at 17¼, a net increase of 1¼. General Electric is higher by 2 points, the closing price being 187. Westinghouse common closed at 180 ex-div., a gain of 2 points, and preferred at 195, a net gain of 4¼ points. Western Union Telegraph closed at 93¼, an advance of 1 point over the last quotations, and American Telephone & Telegraph made a net gain of 2¼, closing at 148¾, which was the highest quotation of the week. The curb market responded to the better sentiment on the Stock Exchange, with some noteworthy gains. Following are the closing quotations of January 3:

NEW YORK

	Dec. 27	Jan. 3		Dec. 27	Jan. 3
Allis-Chalmers Co.	15⅝	16	Electric Vehicle	14⅛	..
Allis-Chalmers Co. pfd	60	66	Electric Vehicle pfd	21	..
American Tel. & Cable	92	93⅛	General Electric	186	187
American Tel. & Tel.	147	148	Hudson River Tel.	..	..
American Dist. Tel.	..	..	Interborough Rap. Tran.	164	..
Brooklyn Rapid Transit	61	61¼	Metropolitan St. Ry.	120⅜	120½
Commercial Cable	..	..	N. Y. & N. J Tel.	166	..
Electric Boat	37	..	Marconi Tel.	..	..
Electric Boat pfd.	72	..	Western Union Tel.	92	94⅛
Electric Lead Reduction	⅛	..	Westinghouse com	180	179
			Westinghouse pfd	190	190

BOSTON

	Dec. 27	Jan. 3		Dec. 27	Jan. 3
American Tel. & Tel.	147¼	147½	Western Tel. & Tel. pfd.	100	*100
Cumberland Telephone	120	121⅛	Mexican Telephone	1⅜	1⅜
Edison Elec. Illum.	254	*254	New England Telephone	137	138
General Electric	185	188	Mass. Elec. Ry.	13¼	13½
Western Tel. & Tel.	20	*20	Mass. Elec Ry. pfd.	57⅛	59

PHILADELPHIA

	Dec. 27	Jan. 3		Dec. 27	Jan. 3
American Railways	48	48	Phila. Traction	98⅛	98⅝
Elec. Storage Battery	77	78	Phila. Electric	10⅜	10¾
Elec. Storage Battery pfd.	77	78	Phila. Rapid Trans.	17⅝	17½
Elec. Co. of America	10¾	11⅛			

CHICAGO

	Dec. 27	Jan. 3		Dec. 27	Jan. 3
Central Union Tel.	..	..	National Carbon pfd.	..	110
Chicago Edison	170	170	Metropolitan Elev. com.	22	22⅛
Chicago City Ry.	..	180¾	Union Traction	..	9⅛
Chicago Tel. Co.	145	..	Union Traction pfd.	39	..
National Carbon	45	44			

*Asked.

THE YEAR STOCK FLUCTUATIONS.—It will be of interest to note some of the fluctuations in leading electrical securities during 1904, as well as the extent of the dealings. Of Western Union, 112,673 shares were sold. For the year a net rise of 6¾ was shown, from 86½. The highest point during the year was 94½. Commercial Cable rose 25 points in the year, from 185 to 210, which was its highest and final quotation. General Electric sold to the extent of 228,225 shares. It opened 1904 at 171⅞, went as low as 151 and as high as 194½, and closed around 187, showing an advance of over 15 points. Westinghouse Electric common was dealt in to the extent of 209,160 shares. It opened at 171, fell to 153, rose to 185, and closed the year at 180, a gain of 9 points. The Westinghouse first preferred began the year at 192 and with slight fluctuations on small dealings closed the year at 195. American Telephone & Telegraph was dealt in on Wall Street to the extent of 22,412 shares. The last quotation of 1903 was 128⅛ and the last of 1904 was 148¾, showing a net gain of 20⅝. Brooklyn Rapid Transit was a busy item all the year, just short of 5,000,000 shares being dealt in. The gain for the year was 8¾, from 52½ to 61¼. The traction securities of New York City also showed a general appreciation, although the new leases and ownerships make these difficult to follow. But Manhattan Elevated made a gain on sales of 531,430 shares, from 144 to 165, or 21 points. Allis-Chalmers preferred showed a decline of 13½ points, but the common had an advance of 10¼. International Steam Pump showed an advance of 14½ on the preferred and 8⅛ on the common.

DIVIDENDS.—Westinghouse Machine directors have declared the usual quarterly dividend of 2½ per cent. on the capital stock, payable January 10. The directors of the N. Y. & N. J. Telephone Co have declared the regular quarterly dividend of 1½ per cent., and an extra dividend of 1 per cent., payable on January 16. The directors of the E. W. Bliss Company have declared the regular quarterly dividends of 2½ per cent. on the common stock and 2 per cent. on the preferred stock, payable January 3. The El Paso Electric Company has declared a semi-annual dividend of $2 per share on the preferred stock, payable January 9. The Mackay Companies has declared the regular quarterly dividend of 1 per cent. on its preferred stock, and an initial dividend of 1 per cent. on its common stock, both payable on January 10. The Oklahoma Gas & Electric Company has declared a dividend of 1¼ per cent. on the preferred stock, payable January 6, 1905.

GENERAL ELECTRIC RESERVE.—According to a Boston dispatch, the fiscal year of the General Electric Company ending with the close of next month, is expected in well-informed circles to show that the reserve fund has increased to about $12,000,000. The company has now a hidden reserve in its property and securities accounts of about $18,000,000.

KALAMAZOO COMMONWEALTH BONDS.—N. W. Harris & Co., of Chicago, have bought $1,200,000 Commonwealth Power Company's 5s of Kalamazoo, Mich.

ARNOLD POWER INTERESTS.—The capital stock of the Arnold Electric Power Station has been increased from $100,000 to $150,000.

General News of the Week

The Telephone.

SAN FRANCISCO, CAL.—The Pacific States Telephone building is to be erected at a cost of $150,000.

FRESNO, CAL.—The application for a franchise for another telephone system has been filed by Frank Mortimer, of the Home Telephone Company, who expects to invest $500,000 in plant and equipment here.

LEWISTON, IDA.—It is expected that the City Council will, at its next meeting, grant a franchise to the Independent Telephone & Telegraph Company to stretch wires and maintain an exchange in this city. The company was organized several months ago by P. Nenrichs, F. M. Hinckley, U. I. Temple, G. Holbrook and F. J. Randolph.

LENA, ILL.—The Howardsville Telephone Company has been formed by E. Fisher, G. W. Davis and others; capital $2500.

GRAYVILLE, ILL.—The Westfall Telephone Company, has been formed, capital $4000. The incorporators are W. F. Westfall, Claude O. Ellis and others.

QUINCY, ILL.—The Quincy Automatic Telephone Company which recently received a franchise, is preparing plans for about five miles of underground work. The plans will be complete by February, 1905, when proposals will be invited, also for several lines of pole line work. Address Jackson R. Pearce, President, Quincy, Ill.

EDWARDSVILLE, ILL.—New equipment, valued at $10,000, is being installed in the Edwardsville exchange of the Central Union Telephone Company. The system is being changed from the magneto to the common battery, and the new switchboard, which has a capacity of 1200 telephones, is of the latest pattern. The force of operators has been increased to five.

CHICAGO, ILL.—The Chicago Telephone Company has just perfected an arrangement whereby Richton, Matteson, Glenwood, Steger and Crete have been added to the Chicago Heights exchange, whose subscribers will have free service at all these places, as well as at Chicago Heights. The company is inaugurating a series of farmer lines in connection with Chicago Heights, which will be built as fast as possible.

CLINTON, ILL.—The Farm & City Telephone Company has sold out its system to the National Telephone & Electric Company which has also bought the Farmers' Interstate Telephone Company. The new company has increased its capital stock from $50,000 to $100,000, all of which has been taken up. The officers newly elected are: President, B. F. Wasson, of Clinton; secretary and treasurer, S. H. Martin, of Waynesville, Ill.

PRINCETON, IND.—The Princeton Independent Telephone Company contemplates installing a new exchange.

FRANKLIN, IND.—The Central Union Telephone Company asked permission to withdraw the proposed local franchise ordinance, seeing that the Council would not pass it in its present form. It is expected that a new ordinance will be presented at an early date. The business men are opposing the granting of the franchise, while the professional men favor it.

LAPORTE, IND.—The Laporte Independent Telephone Company will complete a telephone line between this city and Chicago within the next 20 days, to be operated in conjunction with the automatic system in Chicago, controlled by the Illinois Tunnel Company. There is also a line being constructed from Kendallville to Goshen, and this will connect at Kendallville with the Toledo line. When this gap is completed there will be direct telephone connection between Chicago, Toledo, Cleveland, Pittsburg and other eastern points.

ESTHERVILLE, IA.—The Emmet County Telephone Company will make improvements to its exchange.

SHELDON, IA.—The town will, on Jan. 2, vote on granting a franchise to the Sheldon Telephone Company.

DONAHUE, IA.—The Clare Mutual Telephone Company has been chartered. Capital, $10,000. The incorporators are Charles Donahue and others.

WEBSTER CITY, IA.—The Hamilton County Telephone Company's exchange was damaged by fire recently, and the cables were all soaked with water.

NEW ALBANY, KY.—Farmers and business men of Harrison and Washington counties have organized the Fredericksburg and Ramsey Telephone Company and will build a line across the country between the two towns, affording the farmers along the route, nearly all of whom are stockholders in the company, the convenience. The line will have connection at both Ramsey and Fredericksburg with the large telephone systems running into this city. Officers have been elected by the company as follows: President, F. L. Craydon; secretary, Edward McKinster; treasurer, G. R. Durnill.

FARIBAULT, MINN.—The Council is considering a franchise for a telephone exchange to K. D. Chase and others.

ST. PAUL, MINN.—The Shakopee Telephone Company has amended its articles of incorporation, making the capital stock $50,000.

MINNEAPOLIS, MINN.—The Mississippi Valley Telephone Company, recently bought by Thos. Peebles, of this city, and others, will expend $200,000 in improvements to the system in Iowa. A copper circuit will be built from Muscatine to Keokuk.

RED WING, MINN.—Officers and directors have been chosen for the Red Wing Telephone Company which is to be incorporated, with a capital of $150,000. The officers are A. P. Pierce, president; C. A. Rasmussen, vice-president, and D. M. Neill, secretary.

CHILLICOTHE, MO.—Articles of incorporation have been asked for by the People's Telephone Company, of Chillicothe, which will control the Chillicothe exchange. The company is incorporated for $40,000. A half interest in the exchange was recently sold by Doctor A. W. McArthur, of Kansas City, to W. H. Ellett, president of the People's Bank for $14,000. Mr. Ellett and W. B. Leach are the principal stockholders in the new company.

FAIRBURY, NEB.—The Nebraska Telephone Company is rebuilding its plant in this city. The cable system will also be extended.

LANCASTER, N. Y.—The Independent Telephone Company of Elma has again petitioned the Lancaster Village Board for permission to extend a branch of its line to Lancaster and to establish a public station and instal a number of public telephones in the village.

MINEOLA, L. I., N. Y.—The New York & New Jersey Telephone Company, which is placing its wires underground throughout Nassau County as rapidly as possible, was given permission Dec. 19 by the Board of Supervisors, to lay a subway on all county roads in Glen Cove village, which includes Glen Street, School Street and Glen Cove Avenue.

CHARLOTTE, N. C.—The annual report of the commissioner of labor and printing of North Carolina shows that there are 83 telephone exchanges in the State with 15,632 subscribers, and over 24,000 miles of wire. The total revenues for the year were over $346,000.

CLEVELAND, OHIO.—F. S. Dickson, president of the Federal Telephone Company, recently said, concerning the proposed entrance of anti-Bell long-distance lines into Chicago: "Negotiations have been in progress for some time with that end in view. It means that Chicago will be given independent telephone connection with a very large section of the country. We are now working into Pennsylvania from the west as far as Johnstown, and within a few weeks links will be completed connecting Philadelphia and Baltimore; also, through New York State as far east as Albany. On the south we are working through from Cleveland via Columbus and Indianapolis to St. Louis."

SALEM, ORE.—A mutual telephone company has been organized with a capital stock of $1000, for the purpose of connecting the rural telephone lines already established in Polk County, and to build other lines. The officers of the company are: President, Riley Cravon; vice-president, W. W. Percival; secretary, A. H. Huxley.

CHESTER, S. C.—The Bell Telephone Company has applied for the right to enter the town of Chester, but the local company, backed by citizens, is said to be opposing the move together.

IPSWITCH, S. D.—The Dakota Central Telephone Company has commenced work on its line from here to Faulkton. It is expected to have the line working between here and Powell this winter.

NASHVILLE, TENN.—The Cumberland Telephone & Telegraph Company has announced that on February 1 next an issue of $1,800,000 of stock will be made. The money is to be spent in construction of new lines in Louisiana and Mississippi, and in the enlargement of exchanges in several southern cities, notably that of Memphis.

LYNCHBURG, VA.—The Southern Bell Telephone Company has just completed an additional long-distance circuit between Lynchburg and Danville, and has another in course of construction. This will make three lines for long-distance business between these cities.

WALLA WALLA, WASH.—The State Line Telephone Company has been incorporated with a capital stock of $500. Rights have been reserved to construct and operate telephone lines in the County of Walla Walla and elsewhere. The directors of the company are: President, W. C. Reynolds; vice-president, William Roser; treasurer, P. O. Calvin; general manager, N. E. McCormick.

SHEBOYGAN, WIS.—As a result of a conference between the officials of the Citizens' Telephone Company and State Superintendent C. M. Cottrell, of the Wisconsin Telephone Company, the latter concern has agreed to leave the field in Sheboygan and Sheboygan Falls, and turn over its local service to the Citizens' Company. The Wisconsin Company's long distance system will be connected with the Citizens' exchange.

VANCOUVER, B. C.—The telephone line between Vancouver and Victoria, Vancouver Island, has been opened for business. The length of this system is 100 miles of land line and 14 miles of cable. The toll will be 50 cents for one minute's conversation and 10 cents for every additional 15 seconds. The British Columbia Telephone Company built the line.

HONOLULU, HAWAII.—Plans are now under consideration to establish a wireless telegraph system between a number of South Sea Islands. J. T. Arundel, the manager of the South Sea Guano Company, a London concern that operates the guano beds of Ocean, Gilbert, Marshall and other South Sea islands, is to consider the feasibility of establishing wireless telegraph so as to secure communication between the different islands controlled by his company.

WINNIPEG, MAN.—The Bell Telephone Company will have an active season of construction next season and according to the plans now under consideration, about 200 miles of line will be constructed and put into operation. The main line west will be extended to Virden in prosecution of the plan to ultimately reach along the Canadian Pacific to Regina. The line is now built to Alexander.

OTTAWA, ONT.—The County Council of the County of Waterloo has unanimously passed a resolution endorsing the movement on foot to establish a rural telephone system in the county, and against the granting of exclusive franchises to the Bell Telephone Company, by any of the municipalities of the county which might prevent the rural line from obtaining connection with municipalities.

Electric Light and Power.

LITTLE ROCK, ARK.—The Retail Grocers' Ice Company will construct an electric light plant here.

MAGNOLIA, ARK.—The Magnolia Ice & Light Company is installing another 40-kw, 250-volt, direct current generator. It will operate convertible two and three wire systems of 220 and 440 volts.

RUSSELLVILLE, ARK.—The Merchants' Light & Cold Storage Company, of Russellville, has been incorporated, capital $50,000. Incorporators: A. Bernard, S. J. Smallwood, R. L. Harkey and others.

ALAMEDA, CAL.—It is proposed to install a steam turbine and a 400-kw generator in the municipal electric light plant in this city.

EUREKA, CAL.—The electric power plant of the Eureka Lighting Company was seriously damaged by fire on Dec. 13, the loss being about $30,000.

DUNSMUIR, CAL.—The Southern Pacific Railroad Company is considering the construction of a plant here to furnish light, heat and power to its shops.

SAN FRANCISCO, CAL.—The Consolidated Heat, Light & Power Company has been incorporated with a capital of $300,000 by Wm. Thomas, Mark L. Gerstie, Robt. N. Frick and others.

ULIAH, CAL.—The municipal electric light plant may be enlarged in order to supply the demand for service, or the current supply may be brought from a private plant in the mountains near here.

GAYLORDVILLE, CONN.—The New Milford Power Company expects to build several other plants along the Housatonic River in the near future.

HARTFORD, CONN.—Part of the new plant of the Hartford Electric Light Company at Dutch Point has been put into service, about 600 horsepower having been supplied to the city by the company.

NORWICH, CONN.—R. L. Warner, the New England manager of the Westinghouse Electric Company is reported to have secured rights along Quinebaug and Shetucket Rivers, and proposes to construct a power plant in this section. The idea is to get a charter from the Legislature and sell power in this section of the State.

NORTH CANAAN, CONN.—The Berkshire Power Company has been incorporated in Connecticut with a capital stock of $240,000, to establish an electric power plant at North Canaan, Conn. A large storage reservoir will be constructed. Another Connecticut power project is to establish dams and power stations on the Rocky River at New Milford and the Still River at Lanesville and Brookfield. This is to be done by the Danbury Power Company.

OCALA, FLA.—The municipal electric light system is being enlarged and changed over to alternating current.

TALLAHASSEE, FLA.—Another unit will be installed in the municipal electric light plant in this city some time in January next.

STARKE, FLA.—Considerable extensions are contemplated in the municipal electric light plant and service in this place. Additional arc lamps will be installed, besides a large generator, engine and storage battery plant.

JONESBORO, GA.—It is the intention to duplicate the municipal electric light plant in this city in the near future.

DECATUR, GA.—The Decatur Electric Light, Power & Water Company contemplates the addition to its plant of a 35-kw dynamo at an early date.

CAMILLA, GA.—It is proposed to construct water works and an electric light plant at Camilla at a probable cost of $20,000. Ludwig & Co., Atlanta, are the engineers.

GREENSBORO, GA.—The Mayor and Council have closed a contract with Mr. R. E. Bloomfield, of the Southern Electric Supply Company, Athens, for the electric light plant bonds which were voted in a recent election. By the terms of the contract the lights are to be turned on not later than April 1, the contractor forfeiting $10 per day for every day after that date that the plant is not completed.

VIENNA, ILL.—The Vienna Electric Light Company proposes to build an electric railway 4½ miles.

CHICAGO, ILL.—Bids will be received Feb. 15 by S. D. Griffin, Clerk of the Board of Trustees of the Sanitary District of Chicago, for furnishing and installing, alternating current generators and exciters; said generators to consist of four 4000-kw, 6600-volt, 3-phase, 60-cycle machines, 164 r.p.m., and two 350-kw, 250-volt direct-current generators, 300 r.p.m.

LOOGOOTEE, IND.—E. H. De Wolf has petitioned the Council for an electric light franchise.

GREENFIELD, IND.—It is proposed to increase the engine and boiler capacity in the city electric light plant.

GUTTENBERG, IA.—The Guttenberg Electric Light Company contemplates establishing a power circuit for day service.

CHARLES CITY, IA.—The Charles City Light & Heat Company contemplates changing its lighting from the open arc to enclosed series system.

FAIRFIELD, IA.—The City Council has entered into a contract with the Western Electric Company of Chicago for a new lighting plant to cost $2735. There will be 75 lamps, each of 2000-cp.

TOPEKA, KAN.—It is proposed to change the municipal system of street lighting to enclosed arcs.

STERLING, KAN.—A gas engine and dynamo unit are being installed in the electric light plant here for day service.

GALENA, KAN.—The Spring River Power Company, composed of Chicago men, has completed a large cement dam across Spring River at this place, and a test of the water pressure has been made.

MAYFIELD, KY.—The Mayfield Water & Light Company expects to install a 300-kw, direct-connected, 60-cycle, two-phase alternator and a boiler, after the first of the new year.

KENNEBUNKPORT, ME.—The Kennebunk Electric Light Company will probably add another unit to its present plant next year.

BANGOR, ME.—The City Council has appointed a committee to consider the question and petition the Legislature for authority to generate and sell electric light, heat and power. The City Council is said to have voted to double the capacity of the municipal light plant at the water works, at an expense of $10,000.

PITTSFIELD, ME.—The Sebasticook Power Company has started up its machinery for business, and has begun furnishing electricity to light the homes, offices, stores and streets of Pittsfield. The electrical machinery includes three 300-kw three-phase generators and one 100-kw machine of the same kind. There will also be two 25-kw moderate speed exciters of 125 volts, either machine being capable of exciting all three of the generators. As soon as all is in complete working order, the company will furnish power and light to various industries.

CHELSEA, MASS.—W. M. McDonald and others have petitioned for a public hearing upon the proposition to purchase a municipal electric lighting plant.

FAIRHAVEN, MASS.—The Bay State Tap & Die Company has commenced to operate its plant with power transmitted from the Mansfield electric lighting plant.

FALL RIVER, MASS.—The Fall River Electric Lighting Company has purchased property on Hathaway St. and will within the next two or three years erect a new generating plant at tidewater.

MANSFIELD, MASS.—A special town meeting has voted to appropriate $1900 for increase in the commercial department of the electric lighting system and to light the town hall and library by electricity.

PALMER, MASS.—The annual meeting of the Central Massachusetts Electric Company has been held in Palmer, and officers elected as follows: President, C. E. Fish; vice-president, G. C. Flynt; manager, A. J. Purinton; treasurer, C. B. Fiske; clerk, A. J. Purinton; directors, the above and G. E. Fuller, of Monson, Edward Fairbanks and W. H. Fairbanks, of Warren; A. W. Paige and C. F. Grannis, of Bridgeport, Conn.

DOWAGIAC, MICH.—A new plant for the municipal electric light service is contemplated in this city.

EAGLE LAKE, MINN.—The City Council is considering the question of constructing either a gas or electric light plant.

MINNESOTA CITY, MINN.—The Minnesota Light & Power Company will construct a power plant, part steam and part water power, at Minnesota City, to furnish power and light for Winona, Fountain City and Rollingstone. The plant will cost about $75,000.

YAZOO CITY, MISS.—The Yazoo City new electric lighting plant was put in operation recently.

VERSAILLES, MO.—The City Council has accepted the electric light plant from the St. Louis contractors. The plant is owned and operated by the city, and was built with the proceeds from the sale of $10,000 in bonds.

CARLETON, NEB.—D. H. Kelso, A. E. Frasche and others are interested in the construction of water works and an electric light plant.

LACONIA, N. H.—Allen A. Tirrill, of Schenectady, N. Y., is interested in the construction of an electric power station on Pemigewassett River, at Franklin, N. H., and to bring the current to this city for light and power. It is stated that he has secured an option on the plant of the local electric light company.

BORDENTOWN, N. J.—The Bordentown Electric Light & Motor Company is changing its entire system to alternating, for public as well as private lighting.

EAST NEWARK, N. J.—The United Electric Company, of Newark, has secured the contract to light the streets of East Newark at $100 per lamp per year, for a period of five years.

MONTOUR FALLS, N. Y.—The Montour Falls Electric Light Company proposes to build larger dams and install a new water wheel.

FORT PLAIN, N. Y.—The Fort Plain Gas & Electric Light Company has secured the contract for lighting the village for five years at $60 per light per year.

HAMMONDSPORT, N. Y.—The Hammondsport Electric Light Company states that it will install gas engines and a gas producer plant if they "are successful."

CANAJOHARIE, N. Y.—The Montgomery Electric Light & Power Company proposes to install an auxiliary plant of 250-hp capacity as a reserve in case of accident to the water power plant.

ALEXANDRIA BAY, N. Y.—The St. Lawrence International Railroad & Land Company expects to have water power next year, which, it claims, will be the best in northern New York. It will light Redwood, which is seven miles from Alexandria Bay. The company states that its railroad and light systems have been a success this year.

NEW YORK, N. Y.—The complete World's Fair exhibit of the Weber Gas & Gasoline Engine Company, Kansas City, Mo., which was in service in the Steam, Gas & Fuels Building, has been sold to the Christopher E. Hertlein Company, New York. The plant consists of 150-hp Weber engine and 150-hp suction gas producer, direct connected to a 75-kw Western Electric generator.

MIDDLETON, N. Y.—The transfer of the Orange County Gas & Electric Company by George A. Swayze, receiver, to Philip N. Jackson, who bought the property at foreclosure Nov. 10, has been made, and the new company is

now in possession. The articles of incorporation of a new company to be known as the Orange Lighting Company have been sent to Albany. It is understood that Mr. Leander C. Purdy will be one of the officers and will have charge of the business here.

MURPHY, N. C.—The Murphy Electric Light & Power Company has been incorporated with a capital of $6000. J. Gentry is the principal incorporator.

SALISBURY, N. C.—The Salisbury & Spencer Railway Company is now lighting Chestnut Hill and Spencer, and is building 7½ miles of railway, which is about half finished.

CAREY, OHIO.—It is intended to duplicate the alternating plant in the electric light station in this place.

MIAMISBURG, OHIO.—An issue of $19,000 bonds has been authorized by the village, to be used for enlarging and improving the electric light plant.

NEWARK, OHIO.—The managers of the municipal electric light plant in this city contemplate changing the street lighting to the series alternating current system.

CARBONDALE, PA.—The Hendrick Light & Power Company has petitioned for a franchise for an electric light plant.

WELLSBORO, PA.—The Wellsboro Electric Light Company contemplates establishing a new station and increasing its plant. Mr. L. Harrison is president.

WEST CHESTER, PA.—The Council has adopted a resolution renewing the contract with the local electric light company for lighting the streets for the next five years at $10,000 per year.

PHILADELPHIA, PA.—The Commonwealth Electric Company's ordinance, granting it the privilege to run electric light wires in the conduits it had purchased conditionally from the Keystone Telephone Company, was killed recently by the City Council.

SHENANDOAH, PA.—The council's action in awarding a lighting contract to the People's Light, Heat & Power Company, a new concern, is to be tested in court by the Shenandoah Electric Illuminating Company. That company's bid was $4.50 less per light.

EASTON, PA.—The big electrical plant of the Lehigh Power Company along the Delaware canal, a short distance below Easton, has, it is stated, been seized to satisfy a claim for $3000 held by the Lehigh Coal & Navigation Company for water rent. The plant was recently sold at master's sale to James H. Morris, of Philadelphia, and is being dismantled.

ELLWOOD CITY, PA.—The Ellwood Power Company, Ellwood City, Pa., will shortly be taken over by a larger corporation. The incorporators are R. L. Smith, A. J. Barron and B. R. Thomas, all of Pittsburgh. The new company expects to put in one or more new dams and to go forward with the development of the water power at Ellwood City. The transmission line is completed to West Pittsburgh.

CATASAUQUA, PA.—W. W. McKee, receiver of the Lehigh-Northampton Gas & Electric Company, of Catasauqua, has been authorized by the Lehigh County Court to issue certificates to the amount of $65,000, with which to modernize and increase the capacity of the plants of the company. A direct-connecting engine, a new generator and a new Sterling boiler will be installed and the lines placed in first class condition.

LEXINGTON, S. C.—Samuel B. George, with Julian E. Kaufmann, is interested in the construction of an electric light plant. No engineer has been engaged as yet.

CLINTON, S. C.—Engineer Chas. C. Wilson, Columbia, writes that bids will be received about Feb. 15 for water works and an electric light plant for Clinton. The probable cost is $25,000.

COLUMBIA, S. C.—The Columbia Electric Street Railway, Light & Power Co. has secured the contract for lighting the city for five years. The contract provides for about 200 lights of 1200-cp, at $65 per light per year. The lamps to be lighted from 30 min. after sunset until one hour before sunrise.

COOKEVILLE, TENN.—It was voted to issue $25,000 bonds for constructing water works and an electric light plant.

TULLAHOMA, TENN.—The municipal electric light and water works plant will be in the market shortly for a 150-hp gas engine and gas producer plant. Mr. C. W. Lytle is superintendent, to whom all communications relating to this matter should be addressed.

GEORGETOWN, TEX.—The Georgetown Water & Electric Company will need a new generator next year.

HUMBLE, TEX.—The Commissioners of Harris County at Houston have granted J. Chas. Wilson and F. A. Peter, representing the Humble Electric Company, a franchise to furnish light and power in Humble.

TAYLOR, TEX.—The Taylor Electric Light Company will soon be in the market for two 125-kw, 1100-volt, 133-cycle generators to be direct connected to a steam turbine. The present apparatus will be offered for sale.

MARTINSVILLE, VA.—The citizens have voted to issue $60,000 bonds for the improvement of the water power on Smith River, for the purpose of furnishing light and power to the town. Bids for $30,000 electric light bonds will be received on Jan. 14.

BENWOOD, W. VA.—The Ohio Valley Electric Company, of Benwood and McMechen, has been incorporated, capital $50,000. Incorporators: W. H. Snyder, Charles Schad and Robert Newton, of Benwood, and S. E. Dorsey, of McMechen.

PLATTEVILLE, WIS.—The Platteville Electric Light & Power Company will probably enlarge both its steam and electrical equipment next season, the full capacity of both having been reached.

THOROLD, ONT.—It is the intention to introduce alternating series arcs for street lighting by the municipal electric light plant in this place.

The Electric Railway.

SAN DIEGO, CAL.—President E. S| Babcock, of the San Diego & La Jolla Railroad, announces that the road will be changed from a steam to an electric line and the service quadrupled. It is said that the necessary material has been ordered.

ALTON, ILL.—Two companies will probably petition the Alton City Council at the January meeting for franchises to build electric lines on Belle Street. The street being narrow, but one will probably get the right.

CHICAGO, ILL.—The Union Traction Company, which has been receiving and paying interest on deposits made by employees, has, it is said, served notice on the depositors to withdraw their money. This action is occasioned by the intimation by Judge Grosscup that this money must be considered a trust fund.

SPRINGFIELD, ILL.—The Springfield & Northeastern Railroad Company expects to build 111 miles of interurban road the coming season, according to L. E. Myers, of Chicago, president of the L. E. Myers Company, which has the contract. The main line will extend from Springfield to Bloomington, with a branch from Lincoln to Peoria.

SHELBYVILLE, IND.—Dr. E. P. Light is considering a proposition to construct an electric railway from Greenwood to Cincinnati, by way of Shelbyville, Greensburg and Batesville.

CARLISLE, IND.—D. O. Hazleton, of Vincennes, is closing contracts for the right of way for the electric railway which is to be constructed from Vincennes to Terre Haute, by the Western Indiana Traction Company.

INDIANAPOLIS, IND.—A company is organizing in this city to construct an electric railway from Terre Haute to Vincennes. Dr. W. N. Heath, of this city, has been elected secretary, and has been directed to have a preliminary survey made.

INDIANAPOLIS, IND.—The Indianapolis & Ohio Valley Traction Company has filed articles of incorporation with the Secretary of State. The capital stock is $50,000. Joseph H. Lorimer, Butler Smith, A. E. Fauve, Peter Backer and E. J. Fauve are the incorporators.

LA LAPORTE, IND.—The Indiana Railway Company, operating between South Bend, Mishawaka, Goshen and Elkhart, has been consolidated with the Indiana & Western Railway Company, constructing a line westward from South Bend through Laporte County. The directors of the merged corporations are authorized to issue $3,000,000 in forty-five-year 5 per cent. bonds.

SOUTH McALESTER, I. T.—The Indian Territory Traction Company opened 7 miles of new electric railway Dec. 22. The company has been operating electric cars between South McAlester, McAlester, Busby, Krebs and Alderson, a distance of 8 miles. The extension opened will connect the two mining towns, Bache and Dow. By Jan. 15 the lines now being constructed from Dow to Hartshorne and Hailesville will be opened and 45,000 people will be reached by the 20 miles of road. This is the only electric railway in Indian Territory.

SIOUX CITY, IA.—The officials of the Omaha, Decatur & Northern Electric Railway Company held a meeting in this city recently and decided to award a contract at an early date for the construction of 17 miles of the road between Decatur and Tekamah. It is the intention to have this part of the line completed and in operation by Oct. 1, 1905.

LEWISTON, ME.—Arrangements have been made between the Lewiston, Brunswick & Bath Street Railway and the Libbey & Dingley Company for power to be supplied from the new works at Deer Rips. This power will be used to run the road from Lisbon Falls to Lewiston and also for the Lewiston & Mechanic Falls road, which will probably be built next season.

BOSTON, MASS.—The East Boston Tunnel was formally leased to the Boston Elevated Railway Company on Dec. 24 for a term of 25 years, beginning June 10, 1897, and ending June 10, 1922. The annual rental is to be three-eighths of 1 per cent. of the company's gross receipts from owned, leased or operated lines, besides which the company acts as agent to collect the toll in the tunnel. The toll and the rental go to the city of Boston to be used as a sinking fund to redeem the tunnel bonds and pay their interest. The percentage rental is to be based upon the receipts of each year ending Sept. 30.

OMAHA, NEB.—P. E. Iler, E. C. Hurd and Judge Lake filed a petition with the Board of County Commissioners asking for a franchise through Douglas County for the lines of the Omaha, Lincoln & Beatrice Railway Company, which proposes to construct an electric railway between these points, with a branch line to Fremont.

SYRACUSE, N. Y.—The trustees of East Syracuse have granted a franchise to the East Side Traction Company, of Syracuse, now owned by the Rapid Transit Company of the same city, to build an electric railway from the present terminus of the company's line in that village to the village line in East Syracuse.

SYRACUSE, N. Y.—The Westinghouse Electric & Manufacturing Company is preparing plans, specifications and estimates on contracts for the complete electrical equipment for a new line from the Jamesville terminus of the Syracuse & Suburban Railroad to Pompey and Fabius. C. A. Petrie, of Elmira, is at the head of the project.

FOSTORIA, OHIO.—It is probable that the Toledo, Fostoria & Findlay Railway will build an extension to give it connection with Toledo.

ZANESVILLE, OHIO.—The Southeastern Ohio Railway, Light & Power Company, which proposes to build an electric railway to Crooksville, has been granted a franchise to enter Zanesville.

ALLIANCE, OHIO.—Beginning on Jan. 1, 1905, and until further notice, the pay of all employees on the Stark Electric who have been holding regular runs for one year or more will be 21 cents per hour in place of 20 cents, as heretofore.

CINCINNATI, OHIO.—A letter has been received by Council from the Cincinnati Rapid Transit Railroad Company urging the granting of the franchise for its proposed elevated and subway railway from Third and John Streets to Norwood.

TOLEDO, OHIO.—The stockholders of the Toledo, Bowling Green & Southern Traction Company have voted to lease the property to the Toledo Urban & Interurban Railway Company, which has just completed a new line from Perrysburg to Toledo, affording a better entrance to the city for the Bowling Green line.

TOLEDO, OHIO.—The statement is made that Pfaelzer, Walker & Company, of New York, are arranging to finance the Toledo, Columbus & Cincinnati Railway Company, formed two years ago to build a line from Toledo to Columbus and Cincinnati. The company has done considerable grading and has numerous franchises and right-of-way grants.

TOLEDO, OHIO.—It is stated that the Westinghouse Electric & Manufacturing Company has been asked to estimate the cost of equipping the Indianapolis, Newcastle & Toledo Electric Railway from Toledo to Indianapolis. The road, with its proposed branches, will embrace 140 miles of track. D. M. Parry, of Indianapolis, president of the National Association of Manufacturers, is at the head of the new corporation.

CLEVELAND, OHIO.—Judge Wing, of the United States Circuit Court, has issued a temporary injunction restraining the City of Cleveland and the Forest City Railway Company from attempting to take possession of the Woodland Avenue line of the Cleveland Electric Railway, under the franchises granted some time ago to the so-called 3-cent fare company. A lower court granted a similar injunction a short time ago.

ZANESVILLE, OHIO.—Stockholders of the Zanesville Railway, Light & Power Company will meet Jan. 17 to vote on the proposition of increasing the capital stock of the company from $1,250,000 to $1,500,000, also to vote on an issue of $1,500,000 of bonds with which to refund the present bonded debt of the company, so as to secure a lower rate of interest, and to provide funds for the purpose of making extensions and other betterments. Considerable new work will probably be done next year.

TOLEDO, OHIO.—Three different companies are working to finance and build lines north from Lima to connect with Toledo, thus forming a through line from Toledo to Cincinnati. The Western Ohio Railway Company hopes to build to Findlay next year; the Toledo, Columbus & Cincinnati Railway Company expects to build between Lima and Toledo, paralleling the Cincinnati, Hamilton & Dayton (steam), and a company backed by those interested in the Lima Railway & Light Company is working over a similar route.

CLEARFIELD, PA.—Chief Engineer Hess has begun the work of locating a route for the new electric railway between Clearfield and Curwensville.

POTTSVILLE, PA.—The Pottsville Union Traction Company has decided to begin at once the construction of an extension 8½ miles long from St. Clair to Frackville.

HARRISBURG, PA.—A charter has been granted to the Dravosburg & Jefferson Street Railway Company to build 1½ miles of line on the road leading from Dravosburg to West Elizabeth. The capital stock of the company is $8000, and J. E. White, of Dravosburg, is president.

HARRISBURG, PA.—Col. Patricio Russ, of this city, who owns the Carlisle & Mount Holly Electric Railway, announces that the construction of the line from Mount Holly Springs to Gettysburg is an assured fact. This line will parallel the Gettysburg & Harrisburg Railroad, a steam line, for the greater part of the 25 miles.

SCRANTON, PA.—Application has been made to Governor Pennypacker for a charter for the Lackawanna, Wyoming Valley & Western Railroad Company, to build 20 miles of double-track electric railway line from Wilkesbarre to Nanticoke and to West Pittston. This new road is to be a continuance of the Lackawanna & Valley Railroad running from Carbondale to Wilkesbarre by way of Scranton.

DOYLESTOWN, PA.—The Philadelphia & Easton Trolley Company expects soon to begin the construction of the lines from Danboro to Point Pleasant, and from Tohickon Park to Bedminsterville. Later on the line to Bedminsterville will be continued to Perkasie. A line from Plumsteadville to Dublin and Perkasie is also contemplated. It is also proposed to cut down the running time of cars between Easton and Doylestown.

GREENVILLE, PA.—The name of the Greenville Electric Railway Company has been changed to the Shenango Traction Company. The construction of the line from Greenville to West Middlesex will be commenced as soon as franchise ordinances are passed by the Councils of Sharon, South Sharon, Wheatland and West Middlesex. An extension to Conneaut Lake and Meadville, on the north and to New Castle on the south are strong probabilities.

PROVIDENCE, R. I.—The Boston & Providence Street Railway Company, the concern that proposes to build an electric railway from Needham to Providence, connecting with the Union Company in Providence, and the Boston Elevated at Boston, has petitioned the Selectmen in the several Massachusetts towns through which the line is to be constructed, for franchises to maintain and operate the surface enterprise.

MEMPHIS, TENN.—It is rumored that plans are making for the construction of an electric railway from Mason to Salisbury. Col. F. W. Blees, well known locally and a prominent financier, is said to be interested.

ABILENE, TEX.—The City Council has granted Fred Cockrell and several associates a franchise to build and operate an electric street railway here.

KENOSHA, WIS.—Articles of incorporation have been filed for the Park City Electric Railway Company. The incorporators are: John M. Kehlor, Chester D. Barnes and Levi C. Graves. The company has a capital stock of $25,000.

TORONTO, ONT.—The City Solicitor has been instructed by the Council to take action against the Toronto Electric Railway for criminal neglect in not equipping its cars with power brakes, and for neglecting its tracks and roadbed.

New Industrial Companies.

THE HOYT MOTOR COMPANY, of Brooklyn, N. Y., has been incorporated with a capital stock of $100,000. The directors are G. P. B. Hoyt, Jamaica; F. E. Kruger, Douglaston, and G. A. Phail, Flushing.

THE POSTAL TELEGRAPH BUILDING COMPANY, of New York City, has been incorporated with a capital stock of $10,000. The directors are Clarence H. Mackay, George G. Ward and Edward C. Platt, of New York.

THE BOARDMAN ELECTRIC COMPANY, of Shelby County, Tenn., has been incorporated with a capital stock of $3000. The incorporators are F. E. Boardman, H. B. Hart, G. B. Thornton, Jr., R. M. Ellett and W. G. Long.

THE AMERICAN MOTIVE POWER COMPANY, of New Haven, Conn., has been organized. Two hundred and eighty-three shares of capital stock have been subscribed for, which have been paid for in property valued at $28,300.

THE DETROIT GAS & ELECTRIC FIXTURE COMPANY, of New York City, has been incorporated with a capital stock of $10,000. The directors are Jacob M. Ehrlich, Harry J. Joel, New York, and Charles A. Coppock, Detroit, Mich.

THE CONSTANT SPARK PLUG COMPANY has been organized at Portland, Me., for the purpose of manufacturing electric spark plugs. Capital stock $50,000; $500 paid in. President, H. L. Cram, Portland, Me.; treasurer, Charles H. Weston, Boston, Mass.

THE D. W. PAYNE CONTROLLER & ENGINEERING COMPANY, of New York City, has been incorporated with a capital stock of $48,000 for the purpose of manufacturing governors for motors and engines. The directors are E. P. Hampson and W. A. Robinson, of New York, and D. W. Payne, of Elmira.

THE MANHATTAN & BRONX ELECTRIC COMPANY has been incorporated at Albany with a capital stock of $10,000, to furnish light, heat and power in all five of the boroughs of New York City. The directors are Willis B. Richards, of New Rochelle, and John S. Clark and J. C. Stafford, of Brooklyn. The principal office of the company is in Manhattan.

THE C. T. McCUE COMPANY, of Hartford, Conn., has been formed for the purpose of building, repairing and dealing in all kinds of motors, engines, machines, etc. The company has an authorized capital stock of $50,000 and will begin business with a capital stock of $10,000. The incorporators are Charles F. McCue and Frederic C. Billings, of this city, and Herbert A. Wiley, of Boston.

Legal.

TELEPHONE AND ELECTRIC LIGHT.—An appeal will be taken from the decision of the Baltimore Circuit Court dismissing an injunction restraining the officers of Maryland Telephone & Telegraph Company from negotiating to install an electric power house. It is the intention of this company to go into the electric light and power business in opposition to the United Electric Light & Power Company, but its right to do this under its charter is contested. Hence the effort to continue the injunction.

TELEPHONE SERVICE DENIED.—The application of James G. Weston for a peremptory mandamus, to compel the New York Telephone Company to place a telephone in his place of business at 35 West Twenty-seventh Street and establish telephone connection therewith was denied by Justice MacLean in the New York Supreme Court. Weston said two applications to the telephone company had been rejected and that his business was thereby irreparably damaged. Manager Bethell, of the Telephone Company submitted an affidavit in opposition to the motion in which he said that last May he had received a communication from Police Commissioner McAdoo notifying him that the premises had been raided. There had been in existence a contract between the telephone company and John C. Coyle, and Weston's letter was accompanied with a check drawn by Coyle. An affidavit of Capt. Cottrell telling of the raid was submitted, which showed that Patrolman Jones had managed to gain admittance to the premises, found a poolroom in full swing there, and played the races. The raid was made on Dec. 23, 1903, on warrants issued by Justice Mayer. Those arrested were discharged for want of evidence. Justice MacLean denied the application and added that Weston has an adequate remedy at law "for all the law allows him."

PRESUMPTION OF NEGLIGENCE.—In supporting an appeal made by plaintiff in the suit of Alexander vs. the Nanticoke Light Company, the Supreme Court of Pennsylvania rules that where an electric light company furnishes a patron with an electrical lamp, and he takes it into his hands without knowledge that the wires on his premises are charged with a higher voltage than is safe, and is shocked and injured thereby, under the doctrine of res ipsa loquitur the presumption arises that the company was negligent. In another case appealed at the same time against the same company the Court decided as follows: 1. In an action for the death of plaintiff's husband, caused by a shock given by an electric light furnished by defendant electric light company, the evidence of the death raises a presumption of negligence on the part of defendant. 2. In an action against an electric light company for death of plaintiff's intestate while using an electric light, it was error to charge that the company was only bound to have such appliances as were in common use at the time, and not the most modern and recent ones. 3. Plaintiff sued an electric light company to recover for the death of her husband. About two months prior to his death, defendant had leased its property to another company, but the lease was not recorded until over a year and a half after execution. Plaintiff had no knowledge of such lease until the statutory period within which she was entitled to sue had expired. Bills for lights after the accident had been paid by plaintiff to a clerk at defendant's office, who had receipted for payment in defendant's name; and defendant had, after such accident, remedied defects in the house of another customer. Held, that the question of defendant's liability was for the jury.

Personal.

MR. RUSSELL ROBB has become a partner in the firm of Stone & Webster, of Boston, who are well known as engineers and managers of a number of American traction and lighting companies.

MR. T. F. MAGUIRE is now general manager of the Mexican Telephone Company which is about to instal an extensive underground telephone system in the City of Mexico. The present lines are overhead.

MR. FRANK S. GANNON, vice-president of the Metropolitan Street Railway Company of New York, has become vice-president of the Howland Improvement Company, of Asheville, N. C., which leases the Atlantic & North Carolina Railroad, and he will take charge of its operation. He will not, however, give up his work in New York City.

MR. ALONZO BURT, president of the Wisconsin Telephone Company, has resigned the presidency of the Bell telephone interests in Missouri and Kansas, and will move to Milwaukee. He will take charge of the interests of the Wisconsin Telephone Company. General Manager John D. McLeod will remain in charge of the active management of the company.

MR. FRANCIS B. BADT, consulting engineer, of Chicago, has been visiting New York for the holidays. He had not been seen in the East for some time. He is the Chicago representative for Weston instruments and Ward Leonard specialties and has been devoting a good deal of time to both the factories. Mr. Badt, it is interesting to note, is a German military o..cer, and has fought in earlier days in the Russian army.

MR. EDWIN EDDISON, of the British electrical engineering and contracting firm of L. J. Healing & Company, of Yokohama, has sailed for the Far East after a short visit to the States. The Healing people are represented here by Mr. Francis A. Cundill, of 90-96 Wall Street. They look after the Japanese interests of the Okonite Company, the Elmer P. Morris Company and the National India Rubber Company.

MR. W. S. MONTGOMERY, who was for many years sales manager for the Conover Condenser Company, and for the past year New York manager for the Payne Engine Company, has severed his connection with the latter concern and formed a partnership with G. M. Rogers under the firm name of Rogers & Montgomery, and with offices at No. 147 West 23d Street, New York City. The new firm will deal in a general line of small labor-saving tools and hardware specialties.

MR. W. B. ELLIOTT, formerly works manager of the C. & C. Electric Company, has been appointed general manager of the company to succeed Mr. Campbell Scott, who has resigned. Mr. Elliott brings to this office a wide practical knowledge, having been connected with the manufacturing department of the company during the past 17 years and having risen step by step to his present position. As soon as practicable the executive offices of the company will be located at the works at Garwood, N. J., it having been found necessary to follow the policy of other manufacturers of electrical machinery in this respect.

MESSRS. N. P. SANTAMARINA and J. Marsden, formerly connected with the British Westinghouse Electric & Manufacturing Company, Ltd., have arrived with a view to introducing on this side the Otto arc lamp for the manufacture of which in Great Britain, a Manchester syndicate was recently formed. Mr. Santamarina built the first Bremer lamp in England, the British patents for which are held by the British Westinghouse people. A smooth gradual feed and a capacity of no less than 6000-cp are among the claims made for the Otto light. Messrs. Santamarina and Marsden, while in New York, are making their headquarters with the American Machinery & Export Company, 114 Liberty Street.

MR. S. M. KEEBLE.—A banquet was tendered Mr. S. M. Keeble, of St. Louis, at the Missouri Athletic Club, by the electrical fraternity of the city. The banquet was a testimony to Mr. Keeble of the high esteem in which he was held by his many friends, and was occasioned by the fact that he will shortly leave the Frank Adam Electric Company with whom he has been connected as chief of switchboard and electrical department, to take up his duties as general sales manager, of the Cutter oCmpany, manufacturers of the I. T. E. circuit breakers. He carries with him the best wishes of all with whom he has been connected in business, and a further tribute was paid him in ..e form of a gold watch and chain by the Adam Company, and a diamond studded Masonic emblem by his brother craftsmen.

MR. C. D. WYMAN, a member of the executive committee managing the Stone & Webster electrical properties, has returned from an extended tour of inspection of the Seattle, Tacoma and Bellingham properties on the Puget Sound. He says: "Prosperity seems to be written on the face of the Puget Sound country, and that, too, of a kind which has in it no elements of sporadic boom, but, rather of the most substantial character. Few people in the east realize the great growth of exports from Puget Sound ports. They have increased from $4,000,000 in 1888, to over $32,000,000 in 1903—only $1,000,000 behind San Francisco. Seattle and Tacoma are growing very fast and seem destined to become very large cities. Manufacturing interests have had a great stimulus by the development of extensive water power by the Puget Sound Power Company."

MR. EDWIN T. PENROSE, formerly superintendent of construction of the Public Service Corporation of New Jersey, at Newark, N. J., and who prior to that time was connected with some of the largest electric lighting systems, has been made head of the commercial department of the West Penn Lighting Company. That concern is operating a large central power station at Cornellsville, Pa., and is distributing by means of high tension lines to its various lighting plants at McClellandtown, Uniontown, Fairchance, Dawson, Dickerson Run, New Haven, Scottdale, Mt. Pleasant, Ruffsdale, Youngwood, Greensburg, Jeanette, Manor and Irwin. The company is thus doing a large amount of lighting and power business throughout the coke region of Pennsylvania, and this business has increased in volume to such an extent as to make it essential to reorganize and enlarge the commercial department now put under Mr. Penrose's charge.

MR. E. S. LEA, an authority on the subjects of turbines and centrifugal pumps, has resigned his position as sales manager for the De Laval Steam Turbine Company and has opened an office at 42 Broadway, New York, as consulting engineer. Mr. Lea, prior to his four years' connection with the company named, had a wide experience in the designing and construction of power plants and water works and in the manufacture of general machinery. The recent striking development in the uses of the steam turbine and the centrifugal pump and the lack of exact knowledge regarding the capabilities of the various types now on the market, seem to assure a large measure of success to Mr. Lea, who is the first to enter this important field as an independent consulting expert. He is a member of the American Society of Mechanical Engineers, and an associate member of the American Institute of Electrical Engineers and of the American Society of Naval Engineers.

Trade Publications.

THE ELECTRICAL POWER STORAGE COMPANY, London, England, has again favored its patrons at home and abroad with a very handsome desk pad with calendar and memorandum attachment.

THE TRIUMPH ELECTRIC COMPANY, of Cincinnati, Ohio, manufacturer of dynamos, motors, etc., has issued for 1905 a very handsome large calendar ornamented by the head of a beautiful woman in colors. It is a welcome addition to office equipment.

THE WARD LEONARD ELECTRIC COMPANY, of Bronxville, N. Y., announces that it has placed in the hands of the printer catalogue data covering field rheostats for motor control having 4 to 1, 6 to 1 and 8 to 1 taper in ampere capacity. Catalogue will give the maximum and minimum amperes, resistance, catalogue number, etc. This is the first catalogue ever issued covering field rheostats of such a high taper and suitable for motor control. This catalogue will be ready for distribution within the next ten days.

THE WARNER ARC LAMP.—An interesting circular is issued by the Warner Arc Lamp Company, of Muncie, Ind., in regard to its lamp for direct current series circuits in connection with the Warner multiple series system. In the Warner lamp no effort has been made to feed the carbons down gradually and the designer has therefore been able to leave out a number of parts. The lamp is without dash-pots and similar contrivances. It is a shunt control lamp, but on account of its positive action the bringing together of the carbons with considerable force each time they are fed down prevents parasitic mushrooming effects at the carbon points. The carbons are also separated a considerable distance and with notable force each time the lamp picks up. With regard to the Warner multiple series system, the lamps are wired in multiples of two throughout the entire circuit with a branch box for each pair. Should one lamp give out, the current is thrown through the remaining lamp. Should both lamps become inoperative, the branch box shunts the current automatically around the two cripples leaving the circuit as a whole in full operation. An interesting feature of the lamp is that the outer globe has an open bottom which allows free circulation of air and dissipation of heat, as well as trimming without the removal of the outer globe.

News of the Trade.

THE ALLIS-CHALMERS COMPANY opened new sales offices in Philadelphia on January 1 in the Land Title Building. The offices heretofore maintained by the electrical department of the company, the Bullock Electric Manufacturing Company, in the North American Building have been removed also to the Land Title Building where they have been consolidated with those of the parent company. The new offices are under the charge of Mr. W. A. Wood, and all the varied mechanical interests of the company will be cared for there.

SHEPHERD ENGINES.—The Shepherd Engineering Company, of Franklin, Pa., has been awarded the gold medal for its engines by the Philippine Government Board at the Louisiana Purchase Exposition for their excellence of design, workmanship and operation, the three points most essential in an engine. During the life of the Exposition, the Shepherd Company had three of its engines, two simple and one compound, in service at the power house of the Philippine Exposition, and it was on the strength of what the Government Board saw in these engines in actual service that the medal was awarded. A complete description of these engines will be sent upon application to those interested.

THE EASTERN CARBON WORKS, Jersey City, N. J., are justly proud of their record and reputation for turning out high grade products and their dry batteries, Eastern No. 3 and No. 4, for automobiles, launches, gas engines, and medical work are more popular than ever. The small cells for flash lights won instant recognition for long life and uniformity and satisfied customers with continued orders makes this a lively branch of the firm's business. The Eastern wet cells and carbon specialties of all kinds, generator and motor brushes, have been standard for years, and need no introduction to the buying public. The facilities of their factory in Jersey City, which is one of the largest and most perfectly equipped plants in the world, entirely devoted to the manufacture of batteries and carbon products, enables them to handle orders economically and promptly.

JUST A BUSINESS SUGGESTION.—The firm of W. F. Weiss, certified public accountants, New York City, makes a specialty of audits and investigations of commercial and manufacturing business and has an especially extensive

practice in the electrical industry. It also makes examinations for the purpose of special and general information, and issue certifications as to earnings and financial condition of firms and corporations, etc. The employment of such a firm at this time, the end of the fiscal year of many businesses, will be found advantageous. The examination and review of the various annual statements by certified public accountants is considered good business practice and a measure of safeguard and insurance, aside from the valuable suggestions and practicable and profitable advice which accompany such accountants' reports as to the most economic and advantageous operation and conduct of the business under review.

COAL SUPPLY.—Mr. J. Blair Kennerly, Penn Square Building, Philadelphia, is making a specialty of the supply of coal to electric light and street railway plants, which consume in the aggregate a great many millions of tons every year. He invites correspondence on the subject. In Febuary, 1903, he opened an office in Philadelphia, began to ship the Valley Smokeless coal immediately it being a new operation, and has worked it up to a delivery of 3000 tons daily. He has gained considerable reputation on this as well as great success, having placed it among some of the largest and best known electric and manufacturing plants in the country. He has also organized recently a large concern known as the Kennerly Coal & Coke Company, which will own and operate in Somerset County, Pa. Mr. Kennerly believes that 1905 will be one of the best years coal men have seen on account of the universal activity and improved prospects.

D. VAN NOSTRAND COMPANY.—This well known firm of publishers, 23 Murray Street, New York City, has recently issued a number of excellent books in the domain of electricity and magnetism, etc. One of the most interesting of these is that on "Alternating Current Engineering," by E. B. Raymond, of the General Electric Company's testing department. This useful book has 101 diagrams and figures. Another interesting volume is that on the "Electro-Magnet," by C. R. Underhill, chief engineer of the Varley Duplex Magnet Company. It is a new and revised edition of a book bearing the same name and will be found very useful by all students. Another book, now in the press, is that on "Electric Railways," by Messrs. S. W. Ashe and J. D. Keiley. It is a modern treatise on the subject, dealing with it from both the practical and the theoretical standpoints. Other books issued by this firm include Dr. Perrine's valuable treatise on "Conductors" and a new edition of Dr. Crocker's book on "Electric Lighting," which has already run through four editions. In the mechanical field a most interesting book is noted in the "Experimental Researches on Steam and Hot Water," by Prof. Rateau. At this juncture this should find a great many readers. Another interesting standard work is that by Rankine Kennedy on "Modern Engines and Generators," issued in two volumes.

TELEPHONE STORAGE BATTERY SYSTEM.—The Kusel & Kusel Company, Monadnock Block, Chicago, is offering to the independent telephone exchanges, at a very nominal cost a storage battery system that is economical to install and maintain, and one that does not require a dynamo for the purpose of charging the set. This system is particularly well adapted for the purpose of furnishing current for the operation of the switchboard operator's transmitters, or for flash-light switchboard trunking. In the past it has been customary for exchanges to employ gravity cells or other closed-circuit batteries for the furnishing of current for this purpose. The use of which is considered more or less objectionable. Where a steady and even current is desired, storage batteries are far preferable, owing to their very low internal resistance, and a full current output. In consequence their use often obviates poor transmitter service at the operator's switchboard transmitters. The Kusel & Kusel Company furnishes this storage battery system on all its switchboards regularly, and is also prepared to furnish such outfits to other companies. It will give further and full information concerning this very valuable adjunct to any exchange or company interested. The charging apparatus of these storage cells in the past has been one of considerable importance, as it has been necessary to arrange for expensive apparatus, which a great many companies have not felt like investing in for such a purpose. By the Kusel & Kusel method which, it is asserted, is very simple, desirable and economical to install and maintain, no apparatus, such as dynamos, etc., for the purpose of charging being necessary.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, the well-known builders of telephone apparatus, particularly that intended for rural and toll line operation, has just issued two interesting bulletins in regard to newer features of its work. One of these relates to its divided circuit, two and four-party selective magneto telephones. In principle these telephones are similar, the only difference being that the four-party instruments are equipped with biased ringers, whereas the two-party telephones are equipped with ordinary alternating ringers. The four-party can be converted into a two-party by removing the biasing spring, and by the addition of this appliance the two can be made into a four. The North Company as the result of a long series of tests and investigations, has been able to design a biased ringer which readily permits this change of function and of operation. The circular gives full details as to the modus operandi. The other bulletin relates to cut-in stations. In the operation of rural or toll lines it is often found desirable to separate them into two or more sections which can be operated independently, but obviously any such line cannot be left without a ringer or bell connected to the terminus of each section at the point of division. To perform such work, therefore, it is necessary to use, in addition to the telephone at this point, a switch and ringer, usually mounted in one box and constituting a cut-in station. The North Company has worked this out in very neat and compact form and offer such cut-in stations made up in two forms. In one of these the switching is done by means of a double throw key, and in the other it is accomplished by means of three jacks mounted in the box to be used in connection with a standard switchboard plug and cord. Both types are illustrated in the circular. Among other recent bulletins issued by the North Company during December are those on its permanentiy adjusted receiver, and on its type "K" magneto telephones. Both of these are very full and explicit in their treatment of the subject and are carefully and freely illustrated.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, S. S. Stadtler, 39 S. 10th St., Philadelphia. Next meeting, Boston, 1905.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Conn. Next meeting, New York City, Sept. 19, 20 and 21, 1905.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

AMERICAN RAILWAY, MECHANICAL & ELECTRICAL ASSOCIATION. Secretary, Walter Mower, 12 Woodward Avenue, Detroit, Mich.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Brooklyn, N. Y. Next meeting, Montreal, Can., September 5, 6 and 7, 1905.

AMERICAN STREET RAILWAY ASSOCIATION. Secretary, T. C. Pennington, 2020 State Street, Chicago.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. S. Barstow, New York City and Portland, Ore.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Milwaukee, Wis. Next meeting, Chattanooga, Tenn., May 17, 1905.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Montreal, June, 1905.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Secretary, George B. Tripp, Colorado Springs, Col.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt St., New York.

ELECTRICAL ASSOCIATION OF NORTH DAKOTA. Secretary, S. J. Fuller, Larimore, N. D.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, F. Fish, Rochester, N. Y. Next meeting, Troy, N. Y., January 17, 1905.

ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association.) Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

ILLINOIS STATE ELECTRIC ASSOCIATION. Secretary, H. E. Chubbuck, La Salle, Ill.

INDIANA PUBLIC UTILITIES ASSOCIATION. Secretary, A. M. Barron, South Bend, Ind.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES OF AMERICA. Secretary, Frank G. Jones, 48 West Jackson Boulevard, Chicago.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA Secretary, E. W. Landgrebe, Huntingburg, Ind.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. M. Coleman, Louisville, Ky.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. S. Porter, Eldora, Ia. Next meeting, Dubuque, Ia., April, 1905.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Des Moines, Ia. Next meeting, March 14, 1905.

KANSAS GAS, WATER & ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ky.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, J. E. Davidson, Port Huron, Mich.

NATIONAL ARM, PIN & BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Mich.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y. Next meeting, Boston, July 19, 1905.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, Dudley Farrand, Newark, N. J. Next meeting Denver, and Colorado Springs, Col., June 6-11, 1905.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty Street, New York.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis. Next convention, Milwaukee, Wis., January 18, 19 and 20, 1905.

NEW YORK STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, T. S. ark, N. J. Next meeting Denver, and Colorado Springs, Col., June 6-11, 1905.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Chas. Currie, Akron, Ohio.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, C. J. Miller, Canton, Ohio. Next meeting, Toledo, Ohio, May, 1905.

OLD TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York. Next meeting, New York, N. Y., 1905.

PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. Secretary, G. P. Low, 600 Rialto Building, San Francisco, Cal. Next meeting, Portland, Ore., June 20, 1905.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second Street, Philadelphia, Pa.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION. Secretary, C. W. Hobson. Next meeting, Denison, Tex., April, 1905.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED DECEMBER 27, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys, 140 Nassau St., N. Y.]

778,222. AUTOMATIC CURRENT REGULATOR FOR ELECTRIC MOTORS; Alexander Churchward, New York, N. Y. App. filed July 16, 1903. A shunt connected around the field of a series motor is adapted to increase its resistance automatically when the current exceeds a predetermined value.

778,238. ELECTRIC BRAKE; Edwin R. Gill, New York, N. Y. App. filed Oct. 6, 1900. A system comprising various improvements, the braking action being obtained by combining a slow rotation of the wheels with a sliding of their circumferences on the track.

778,242. ELECTRICAL CONTROLLING APPARATUS; George H. Hill, Glenridge, N. J. App. filed June 27, 1902. Means for preventing a too rapid progression of the contacts, comprising a checking device acting with the successive contact devices to check temporarily the operation of the suceeding contact device.

778,252. GAS BURNER ATTACHMENT; William Kohn, Brooklyn, N. Y. App. filed Jan. 19, 1904. Details.

778,256. ELECTRIC RAILWAY; Joseph Dela Mar, New York, N. Y. App. filed March 8, 1904. The third rail is protected by a housing, the roof of which is a contact surface for the car shoe, being sectional and connected with the rail by sliding bars actuated successively by the car.

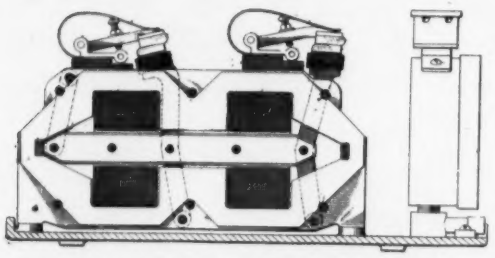
778,269. PROCESS OF ELECTRIC WELDING; Adolph F. Rietzel, Lynn, Mass. App. filed Feb. 6, 1904. The process consists in welding one side of a link or ring and drawing out the welded side to remove the stress developed in the opposite side by the pressure applied to form the weld.

778,275. ADJUSTABLE BOLOMETER DETECTOR FOR ELECTROMAGNETIC WAVES; Charles K. Salisbury, Lincoln Township, Ia. App. filed April 22, 1904. Comprises two metallic plates each of which has a sharp edge which crosses the edge of the other.

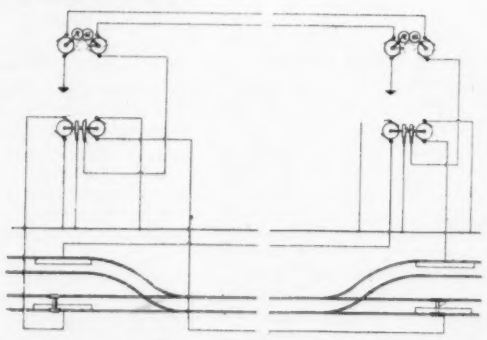
778,280. INCANDESCENT LAMP SOCKET; Clarence C. Sibley, Perth Amboy, N. J. App. filed Nov. 24, 1902. The switch mechanism of the socket is housed within a recess formed in a solid block of porcelain.

778,281. INCANDESCENT LAMP SOCKET; Clarence C. Sibley, Perth Amboy, N. J. App. filed Dec. 11, 1902. Further improvements in the same style of socket as the one last above referred to.

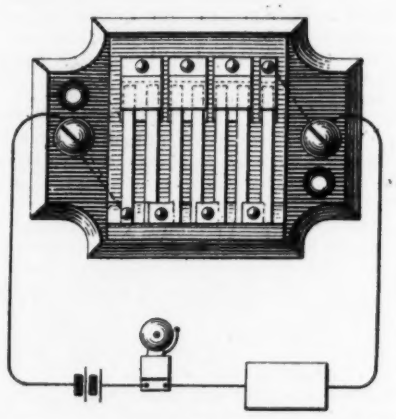
778,297. COMPOSITE-SYSTEM DUPLEX TELEGRAPH CIRCUITS; William E. Athearn, New York, N. Y. App. filed May 13, 1904. A double-conductor telephone circuit, two single conductor earth-completed telegraph circuits, including respectively the two telephone conductors, bridge-



778,333.—Electric Current Governor.



778,356.—Railway Signal.



778,779.—Thermostat.

duplex connection for one of the telegraph circuits and a reactance device having a coil in each of the station arms of the bridge and arranged to offer greater impedance to incoming than to outgoing current.

778,308. THERAPEUTIC ELECTRODE; George H. Day and Frank J. Stein, Louisville, Ky. App. filed July 13, 1904. A receptacle of glass shaped to fit the body at one end and having a chamber into which a metallic electrode projects, absorbent material being attached to the end of the electrode.

t778,322. TELEPHONE-CIRCUIT; John W. H. Maclagan, Parkridge, N. J. App. filed June 23, 1900.

778,333. ELECTRIC CURRENT GOVERNOR; Walter J. Richards, Milwaukee, Wis. App. filed April 11, 1903. A switch for opening and closing alternating current circuits according to variations in conditions, comprising a laminated field provided with coils, a plunger movable axially in the coils and connected with the movable part of the switch and a primary switch controlling the supply of the current to the coils.

778,356. RAILWAY SIGNAL; Frank L. Fuller and Charles S. Banghart, New York, N. Y. App. filed March 21, 1904. The signals are operated by the mere passage of the car into and out of the block, the car passing over an insulated section of track rail in such manner that the car wheels and axles will close and convey the signal current to actuate the signals at each end of the block.

778,376. TROLLEY HARP AND GUARD; Stephen G. Reynolds, Easton, Pa. App. filed June 29, 1903. Details.

778,383. INCANDESCENT ELECTRIC LIGHT SOCKET; Luttrell H. Stuart, Chicago, Ill. App. filed Aug. 14, 1903. Details.

778,400. ELECTRIC MOTOR; James H. Bryson, St. Louis, Mo. App. filed April 21, 1904.

778,409. TELEPHONE APPARATUS; Oscar M. Frykman, St. Paul, Minn. App. filed April 20, 1903.

778,418. RAILWAY BLOCK SIGNAL SYSTEM; Rector E. Land, Mount Washington, Mo. App. filed April 25, 1904. Details.

778,420. DEVICE FOR ATTACHING INSULATORS TO CROSS-ARMS; Fred M. Locke, Victor, N. Y. App. filed April 29, 1903. A conical pin rests upon the upper surface of the cross-arm and is held thereto by a ring embracing its base and clamped by a strap passing around the under side of the cross-arm.

778,435. BOAT PROPELLER; George F. Atwood, Wakefield, Mass. App. filed March 11, 1904. A motor is arranged at the upper end of a vertical shaft mounted in the stern of the vessel and connected at its lower end by bevel gear with the propeller.

778,444. ELECTRIC CIGAR LIGHTER; William P. Carstarphen, Jr., Denver, Col. App. filed April 4, 1904. On closing the circuit to heat the lighter, a lamp is lighted at the same time to display a sign.

778,489. ELECTRIC ARC LAMP; Albert W. Hendricks, Pittsburg, Pa. App. filed March 30, 1904. Details.

778,507. INSULATING AND SUSPENDING DEVICE; Joseph Sachs, Hartford, Conn. App. filed March 16, 1904. A strap support and a strap suspender are connected by an interposed block of insulating material, the entire central body being inclosed in an insulating casing.

778,520. TROLLEY; John S. Weckman, Carnegie, Pa. App. filed Sept. 22, 1904. Details.

778,529. INSULATING MATERIAL AND PROCESS OF PRODUCING SAME; Frederick H. Bruening, Pittsburg, Pa. App. filed Nov. 1, 1904. A compound of cork, tar, ground flint, clay, feldspar, rosin and litharge, mixed in certain proportions and treated in a certain way.

778,531. ELECTRIC FUSE SWITCH BOX; Louis W. Downes, Providence, R. I. App. filed May 20, 1904. The two parts of the box carry respectively the holders for the fuses and the contact clips which engage the terminals of the fuses.

778,560. SUPPORTING AND SHIFTING BATTERY FOR AUTOMOBILES; Allan H. Whiting, Orange, N. J. App. filed Sept. 19, 1903. The upper edge of the battery box is provided with flanges which slide into grooves on the under side of the vehicle and a lifting platform moves into position under the box, lifts it slightly and permits it to be withdrawn laterally from the vehicle.

778,569. SUPERVISORY APPARATUS FOR TELEPHONE SYSTEMS; William W. Dean, Chicago, Ill. App. filed July 7, 1902.

778,575. QUICK BREAK HIGH TENSION ELECTRIC SWITCH; Henry K. Gardner, Providence, R. I. App. filed Dec. 21, 1903. Details of an oil switch.

778,599. TELEPHONE-EXCHANGE SWITCHBOARD APPARATUS; James L. McQuarrie, Chicago, Ill. App. filed Feb. 1, 1902.

778,618. MEANS FOR SUPPORTING ELECTRIC LAMPS AND ENERGIZING AND LIGHTING SAME; William H. Wilkinson, Boston, Mass. App. filed April 29, 1904. A small electric lamp placed in front of a gauge is conveniently connected with a battery and circuit closer for temporarily lighting the face of the gage.

778,643. CONTROLLER; John P. Durkin, Philadelphia, Pa. App. filed Oct. 15, 1904. An automatic catch on the controller handle strikes a stop at each position of the handle requiring slight backward movement of the handle to release the catch before it can be moved forward.

778,666. FLEXIBLE CONDUIT; Albert J. Hoskins, San Francisco, Cal. App. filed July 1, 1904. The conduit is built up of layers of spirally wound asbestos and mica scales.

778,681. ELECTRICAL CONNECTOR; Hubert Krantz and Ernest W. Muller, Brooklyn, N. Y. App. filed March 15, 1904. A connecting board having a row of binding posts and a corresponding number plate for each post, the conductors passing up through a hole in the board and in the number plate to the respective posts.

778,693. ELECTRICAL OUTLET BOX; Ernest W. Muller, Brooklyn, N. Y. App. filed April 24, 1903. The edge of the box is flared and the cover has a correspondingly shaped rim fitting it.

778,707. IGNITING DEVICE FOR INTERNAL COMBUSTION ENGINES; Fritz Reichenbach, Charlottenburg, Germany. App. filed Feb. 26, 1904. An eye-shaped stationary armature has pole pieces whose faces more than bridge the spaces between the corners of the poles of a rotary magnet, thus preventing air gaps and avoiding a pulsatory current in the armature.

778,714. ELECTRIC COMPENSATOR; Edmund O. Schweitzer, Chicago, Ill. App. filed Dec. 13, 1903. The compensator comprises a part whose resistance is varied by changes of temperature and another part comprising a fixed resistance, such parts being connected in parallel and together included in the derived circuit of a measuring instrument.

778,729. BRAKE OPERATED SIGNAL OR TAIL LIGHT; Samuel N. Wilcoxson, Collinwood, Ohio. App. filed June 7, 1904. A circuit closer is attached to the brake rigging of a vehicle, so that when brakes are applied a tail lamp will be lighted.

778,779. THERMOSTAT; Albert Goldstein, New York, N. Y., and Horace E. Rice, Philadelphia, Pa. App. filed May 23, 1903. A thermostat comprising a number of contacts which are successively actuated directly by the heat, the number of closures indicating the location.

778,784. SAFETY DEVICE FOR GAS PRESSURE; Charles Holmok, Cleveland, Ohio. App. filed Dec. 26, 1903. The pressure of gas in a pipe normally holds a float at a certain elevation, cessation of the pressure allowing the float to drop and close an alarm circuit.

778,798. FRAME FOR ELECTRICAL MACHINES; Francis A. Pocock, Lansdowne, Pa. App. filed Oct. 17, 1902. A motor frame having an excess of metal at certain points not needed when the motor is running under certain conditions, but required when running under other conditions.

778,825. SYSTEM OF MOTOR CONTROL; George H. Hill, Schenectady, N. Y. App. filed July 25, 1904. A modification of patent 778,242.

778,832. ELECTRIC TRACTION; Henry B. Greenwood, Buenos Ayres, Argentina. App. filed July 16, 1904. Metallic links of sheet metal resting in a tube upon the main conductor are lifted successively by a magnet carried by the car, into contact with the top of the tube so that the car may take current therefrom.